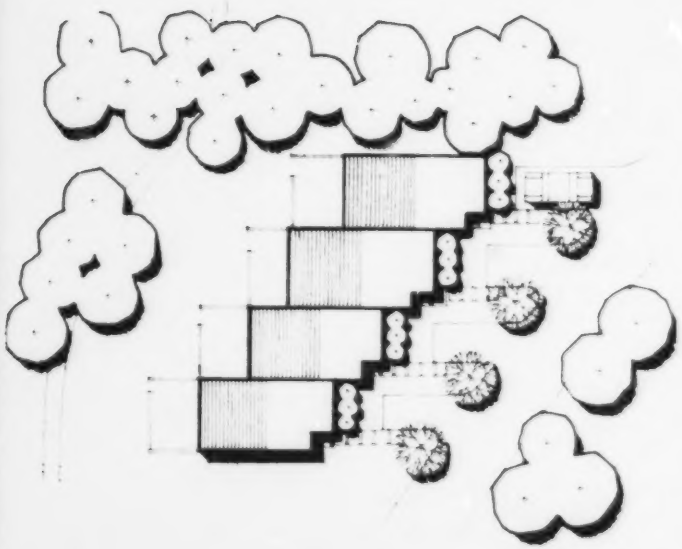
...ciation
...ques et de logement

LANDSCAPE ARCHITECTURAL DESIGN AND MAINTENANCE



CMHC making
Canada a better
place to live

LANDSCAPE ARCHITECTURAL DESIGN AND MAINTENANCE

Aussi disponible en français sous le titre de
Concept paysager et entretien de l'aménagement

Price: $8.00

Canada Mortgage and Housing Corporation
Société canadienne d'hypothèques et de logement

Honourable Paul Cosgrove
Minister

© Canada Mortgage and Housing Corporation, 1982

ISBN 0-660-11108-X
Cat. No. NH 17-17/1982E

Printed in Canada

92-05862/

CONTENTS

Acknowledgments v

Introduction vi

Chapter 1 Landscape Design Process 1
- 1.1 Housing Project Development 3
- 1.2 Site Program and Design Goals 7
- 1.3 Landscape Design Components 11
- 1.4 Design Process and Site Analysis 12
- 1.5 Summary Checklist 14

Chapter 2 Site Layout 15
- 2.1 Conceptual Site Layout 17
- 2.2 Detailed Site Layout 19
- 2.3 Vehicular Access and Parking 22
- 2.4 Pedestrian Circulation 25
- 2.5 Amenity Area 26
- 2.6 Garbage Collection and Removal 27
- 2.7 Snow Storage and Removal 28
- 2.8 Security, Vandalism and Lighting 29
- 2.9 Summary Checklist 29

Chapter 3 Grading 31
- 3.1 Functional and Aesthetic Aspects 33
- 3.2 Gradients 34
- 3.3 Grading Plan 35
- 3.4 Walls and Steps 38
- 3.5 Surface Drainage Features 44
- 3.6 Summary Checklist 50

Chapter 4 Hard Materials 51
- 4.1 Material Applications and Selection 53
- 4.2 Paving Materials 56
- 4.3 Walls and Fences 64
- 4.4 Site Furniture and Other Features 69
- 4.5 Site Lighting 75
- 4.6 Signage 76
- 4.7 Summary Checklist 78

Chapter 5 Plant Materials 79
- 5.1 Functional Applications 81
- 5.2 Aesthetic Values 86
- 5.3 Growth Requirements 87
- 5.4 Plant Selection 92
- 5.5 Summary Checklist 98

Chapter 6 Construction and Maintenance 99
- 6.1 Erosion Control 101
- 6.2 Construction 103
- 6.3 Construction Supervision 105
- 6.4 Maintenance Programs and Budgets 109
- 6.5 Maintenance Procedures 115
- 6.6 Summary Checklist 120

Appendices 121
- A. Glossary of Site Terms 123
- B. Climatic Data 126
- C. Typical Maintenance Schedule 128
- D. Typical Landscape Maintenance Specification 130
- E. References 137

Index 139

ACKNOWLEDGMENTS

Canada Mortgage and Housing Corporation wishes to acknowledge that the research and preparation of this publication were carried out by the consulting firm of Lombard North Group Ltd., Calgary, Edmonton and Victoria, with the assistance of R. Williams, Landscape Architect, Montreal.

All phases of the project were supervised by a CMHC management committee, with Phillip S. Tresch as the Project Manager. CMHC Field Offices and the National Capital Commission reviewed the work in manuscript.

INTRODUCTION

Canada Mortgage and Housing Corporation is publishing a series of advisory documents to help improve the quality of the Canadian housing environment by making it more cost effective. *Landscape Architectural Design and Maintenance* is part of this advisory document series. It was written after a study of the relevant literature, field investigations of projects throughout Canada and interviews with those who work in housing design and operation.

It is hoped that this book will prove helpful to developers and builders, as well as designers and consumers. This would include owners of detached dwellings, managers of rental properties and condominium associations. The publication combines in one volume new and previously published information on landscape architecture in Canada. Particular emphasis is given to multiple-family housing, but the illustrated design solutions and technical details are adaptable to all densities of site development, from single-family detached dwellings to high-density complexes.

This advisory document deals with the related physical and financial aspects of landscape architectural design, construction and maintenance. The introductory chapter on the landscape design process presents a number of development process and cost-effective factors that are often overlooked. The next four chapters explore the major landscape architectural components of site layout, grading, hard materials and plant materials. Then the important topics of construction and maintenance are discussed. Each chapter generally consists of typical solutions for certain identifiable design and maintenance situations, and ends with a summarized checklist. For simplicity, the term "landscape architectural design" is abbreviated throughout the book to "landscape design".

The publishers welcome comments and suggestions, which should be addressed to:

Director, Development Evaluation and Advisory Services Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa, Ontario
K1A 0P7

CHAPTER 1 — LANDSCAPE DESIGN PROCESS

Before embarking on a detailed landscape design or creating a maintenance program for a housing project, the owner and designer must consider a number of factors to do with the overall development of the site. The purpose of this chapter is to explain briefly the housing project development process, including major building and site influences, the site program and landscape design components. Design process and site analysis are discussed at the end of the chapter.

1.1 HOUSING PROJECT DEVELOPMENT

Landscape design is just one part of the development of a housing project. It has been found that a multi-disciplinary approach to medium- and high-density projects produces the best results. Such an approach requires the project's architects, landscape architects and engineers to coordinate all aspects of design and construction. In the preliminary discussions, property management and maintenance needs should also be borne in mind, especially for rental and condominium housing projects.

Landscape design should be an integral part of the total design, whatever the site density. For example, if major decisions on site layout and grading are not resolved early in the design process, they will create problems which can be corrected only at great cost. The practice of "landscaping" a project after the major design elements have been arbitrarily decided upon achieves nothing more than a "cosmetic" decoration of the site because specific problems are not addressed. This book shows how such problems can be resolved through landscape design. Generally, the quality of housing is improved by site development that is functional, aesthetically pleasing and cost effective, which means that the costs of site construction are less than the costs of problems which have been avoided or the increased value of the property.

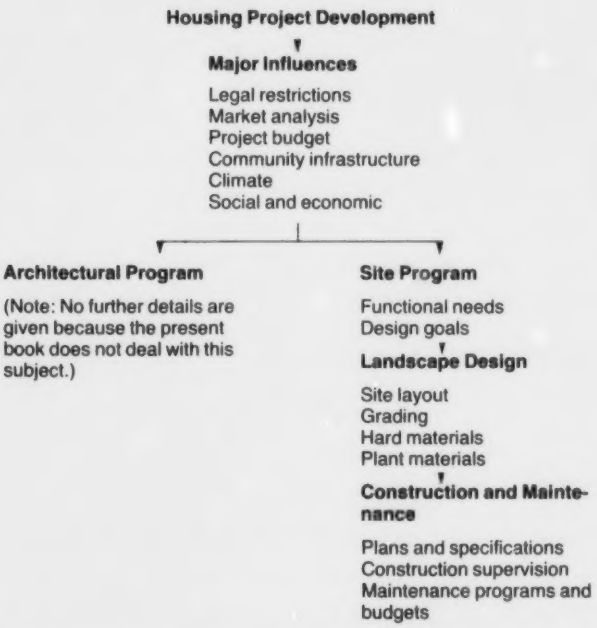


Fig. 1 The relationship of landscape design, construction and maintenance to the overall housing project development process.

Fig. 2 This landscape design illustrates the integration of site layout and grading, as well as hard and plant materials (sometimes called "hard" and "soft" landscape materials).

If the following list of five typical influences on the design and development of a housing project is studied early in the planning process, problems will be avoided.

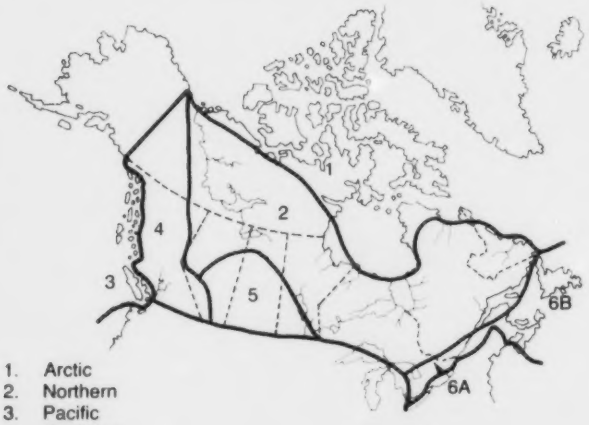
LEGAL RESTRICTIONS. The zoning classification of a proposed housing site will indicate permissible densities, housing types, site coverage and other legal requirements. The bylaws within a given community will define the zoning categories and will specify requirements such as building set-backs, maximum heights, parking ratios, fire access and some aspects of landscape development. Often, to achieve a degree of uniformity, land developers will impose additional development control guidelines on building materials, fencing and building groupings. National, provincial and local building codes should be consulted to ensure that the project complies with public health and safety requirements.

MARKET ANALYSIS. This is simply the gathering of information on the potential housing market within a particular area; frequently, for larger housing projects, it is carried out to determine the desired number or percentage of particular housing types to include. The specific requirements or amenities that the target market group will probably want are also determined. For example, a multi-family development would normally include children's play facilities, while a condominium project designed for single people and childless couples may provide only tennis and other adult recreational facilities.

BUDGETS. The cost limitations for both housing unit construction and site development are usually established after investigating the competition from other housing projects, project financing, and the need to achieve a profitable return on investment. Unfortunately, the budgets for both landscape construction and maintenance are often so inadequate that they become a barrier to accomplishing an optimum plan. If compromises have to be made for various building and site features, they should be decided upon only after ensuring that the target audience from the market analysis would approve. Budgets and other decisions of similar importance should be made as early as possible in the development process.

COMMUNITY INFRASTRUCTURE. This consists of utilities, services and the location of such community facilities as parks, schools, roads and walkways. Such facilities obviously influence the site planning of the housing project.

CLIMATE. Climatic variations have a tremendous influence on landscape design and maintenance requirements in Canada. The climate of a region is determined by temperature ranges, humidity, precipitation, wind and hours of sunshine. As Figure 3 illustrates, the Atmospheric Environment Service of Environment Canada has determined the six general climatic regions of the country. Because of the demography and physical diversity of the Southeastern Region, it is sub-divided:

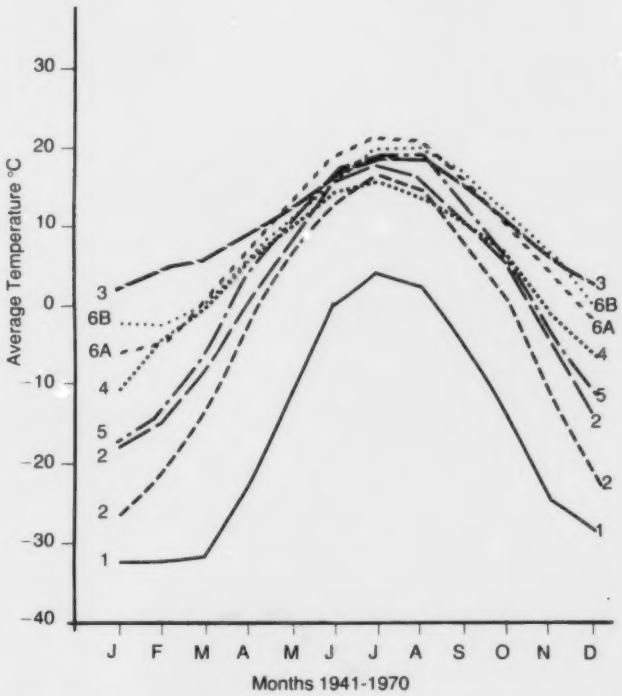


1. Arctic
2. Northern
3. Pacific
4. Cordillera
5. Prairie
6A. Southeastern – Great Lakes/St. Lawrence
6B. Southeastern – Atlantic

Fig. 3 Each climatic region of Canada contains distinctive characteristics that affect landscape design and maintenance. Source: Environment Canada, Atmospheric Environment Service.

The mean daily temperatures of representative cities within each region are shown in Figure 4. It is important to note the extremes and the relative number of months when mean temperatures exceed 0°C. For example, the mean annual variation in Resolute, Fort Smith and Regina is more than 35°C, compared to 16°C in coastal Vancouver and 19°C in Halifax. The Pacific region has a full twelve months with mean temperatures above 0°C; Atlantic, nine months; Great Lakes/St. Lawrence, eight; Cordillera, seven: Prairie, six; Northern, five; and Arctic, two.

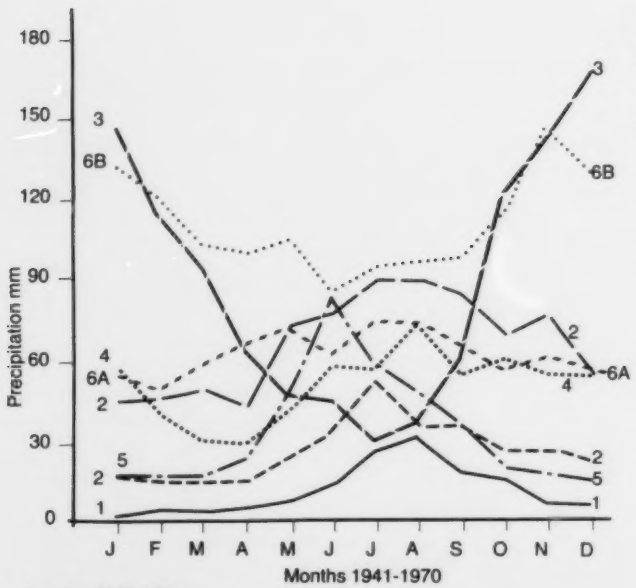
Fig. 4 Mean daily temperatures for representative Canadian cities. See Appendix B for numerical details of this chart. Source: Environment Canada, Atmospheric Environment Service, Canadian Normals, Volume 1-SI, 1941-1970.



1. **Arctic Region** ——————
   Resolute, N.W.T.
2. **Northern (Sub-Arctic) Region** – – – – – – – –
   Fort Smith, N.W.T.
2. **Northern (Sub-Arctic) Region** — — —
   Kapuskasing, Ontario
3. **Pacific Region** — — — —
   Vancouver, B.C.
4. **Cordillera Region** .....
   Prince George, B.C.
5. **Prairie Region** — · — · —
   Regina, Saskatchewan
6A. **Southeastern-Great Lakes/ St. Lawrence Region** – – – – – – – –
   Toronto, Ontario
6B. **Southeastern-Atlantic Region** .....
   Halifax, Nova Scotia

Precipitation rates for each region are compared in Figure 5. The seasonal distribution of precipitation varies considerably throughout Canada. For example, annual precipitation rates are relatively low in Arctic and Northern locations, but the snow tends to accumulate because of the consistently low temperatures. In contrast, Pacific Region annual rates are high, with the greatest accumulations occurring as rain in the winter; summers in this region are dry. The Atlantic areas have similar high annual rates but are more uniform throughout the year; snowfall is high in winter. The Great Lakes/St. Lawrence Region experiences the most uniform rates from month to month. The Prairie and Cordillera Regions have lower annual amounts of precipitation, with maximum rainfall in early and late summer respectively. Winter precipitation is higher in the B.C. interior than on the Prairies. It is interesting to note that the annual variations of precipitation by region are considerably greater than those of temperature and daily bright sunshine.

Fig. 5 Mean total precipitation. See Appendix B for numerical details of this chart. Source: Environment Canada, Atmospheric Environment Service, Canadian Normals, Volume 2-SI, 1941-1970.



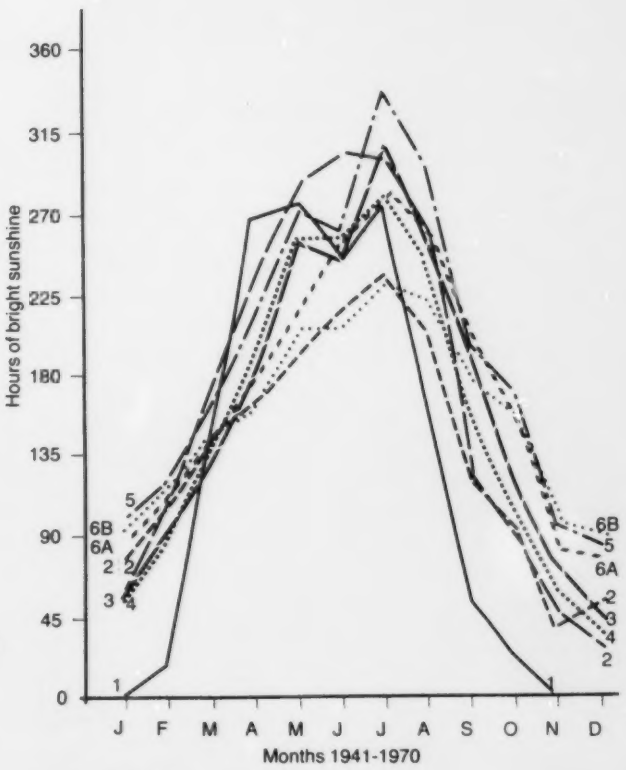
1. **Arctic Region** ——— Resolute, N.W.T.
2. **Northern (Sub-Arctic) Region** – – – – – – – – Fort Smith, N.W.T.
2. **Northern (Sub-Arctic) Region** — — — Kapuskasing, Ontario
3. **Pacific Region** — — — — Vancouver, B.C.
4. **Cordillera Region** ..... Prince George, B.C.
5. **Prairie Region** — · — · — · Regina, Saskatchewan

6A. Southeastern-Great Lakes/ St. Lawrence Region – – – – – – – – Toronto, Ontario

6B. Southeastern-Atlantic Region ..... Halifax, Nova Scotia

Figure 6 shows that the hours of bright sunshine within a given region influence both the design and the potential seasonal use of outdoor areas in housing projects. In the summer months, for example, the Prairie and far northern areas experience the most sunshine and the Atlantic Region the least. In winter, the Atlantic, the Prairie and the Great Lakes/St. Lawrence Regions have more hours of bright sunshine than the Arctic Region.

Fig. 6 Daily bright sunshine. See Appendix B for numerical details of this chart. Source: Environment Canada, Atmospheric Environment Services, Daily Bright Sunshine, 1941-1970, B.J. York and G.R. Kendall.



1. **Arctic Region** ——— Resolute, N.W.T.
2. **Northern (Sub-Arctic) Region** – – – – – – – – Fort Smith, N.W.T.
2. **Northern (Sub-Arctic) Region** — — — Kapuskasing, Ontario
3. **Pacific Region** — — — — Vancouver, B.C.
4. **Cordillera Region** ..... Prince George, B.C.
5. **Prairie Region** — · — · — · Regina, Saskatchewan

6A. Southeastern-Great Lakes/ St. Lawrence Region – – – – – – – – Toronto, Ontario

6B. Southeastern-Atlantic Region ..... Halifax, Nova Scotia

Seasonal prevailing winds are another important climatic factor that influences site design. Wind data may be obtained from local weather offices. An understanding of wind and other climatic conditions will help to improve site design. Such matters as snow removal, irrigation, weather protection and wind breaks, as well as the extent and type of outdoor amenity areas, can be resolved more quickly if information on seasonal prevailing winds is readily available.

Social and economic factors are also important influences on the design and development of a housing project. Canada's various regions are remarkably diverse socially, economically and culturally. The landscape designer must be sensitive to the way these differences will need to be expressed in the development of the site's landscape design. The principal factors include:

- the ethnic composition of the community and the traditional use of landscape related to dwellings (decoration, agricultural production, recreation, function)
- regional family-income levels
- family sizes and dominant household types; (traditional, single parent, singles, seniors)
- particular lifestyle considerations; for example, a person's interest in the use and maintenance of outdoor space
- project density (regionally acceptable levels)
- proposed project tenure (rental or homeownership).

Fig 7. The limited amount of front yard space, created by situating the building close to the street, is characteristic of certain city neighbourhoods.

Fig 8. Regional lifestyles and individual ownership dictate the acceptable levels of site maintenance.

A designer must take the time to identify and understand particular regional influences. For example, designers sometimes make the mistake of repeating similar architectural or site design solutions in all parts of Canada, with no regard for regional, social, economic and climatic variations. Another factor which influences site development is the local availability of landscape materials and experienced landscape contractors.

People who cannot afford, or who do not wish to own their residence, often choose to live in higher-density housing developments. These housing projects frequently provide a communal outdoor space but minimal individual private spaces, and this could lead to a site design that is economically satisfactory but one that does not meet general social needs.

Fig 9. One lifestyle option, reflecting cultural preferences and economic considerations, is this apartment building.

1.2 SITE PROGRAM AND DESIGN GOALS

The site development program establishes the site uses and functional considerations that are to be incorporated into the design. It could be considered a preliminary master plan for guiding the project's development because it is a written list of objectives and priorities to be evolved into the final detailed design plans. The program should reflect the influence of such factors as legal restrictions and market analysis. Ideally, decisions to do with the architectural and site program will be made by the owner and a multi-disciplinary design team. The following are examples of a site's functional needs:

- vehicular access (tenant/owner, fire, garbage, service)
- parking for tenants and visitors (number and location in relation to dwellings)
- storage areas (communal and individual)
- pedestrian access and circulation (including requirements for disabled persons)
- utility corridors (sanitary sewer, storm sewer, water, gas, electrical, telephone, cable television)
- site utility and service requirements (water and irrigation, electrical outlets, automobile plug-ins, lighting, gas)
- drainage systems (parking lots, roadways, roofs, paved areas, lawns, planted areas)
- garbage storage systems and where they should be placed
- outdoor activities and spaces (communal and individual, active and passive)
- recreational areas (adult, preschooler play space, and school-aged children play space)
- site furniture (lighting, seating, waste containers)
- snow (storage areas and removal procedure)
- maintenance (private and communal areas).

Certain design goals are important to owners, developers and residents and will influence the site development program and subsequent design details. The following design goals are particularly important in relation to costs, both initial and long-term.

CAPITAL VERSUS LONG-TERM MAINTENANCE COSTS. The developer must balance the quality of the initial construction with the long-term maintenance costs. A lower capital cost for construction can be achieved by using less durable materials and site details, but usually this leads to greater upkeep and replacement costs. Capital costs are a one-time expense, whereas maintenance costs are long-term and increase with inflation.

Fig 10. A higher capital cost was required for this method of slope stabilization, but annual and long-term maintenance costs will be reduced. Also, additional privacy and usable space has been provided behind the fence.

LOW MAINTENANCE SITE DESIGN. If there is adequate budgeting for site development, projects will normally be built which require little maintenance. In addition, designing specifically for low maintenance can provide the desired result and need not necessarily increase costs. Examples of low maintenance site design include: locating lawn and shrub areas to allow easy movement of mechanized equipment; adding an automatic irrigation system; using paved maintenance strips at the edge of lawns or planting beds to eliminate hand-trimming; increasing the percentage of hard-surfaced areas over lawns or planting beds; and using hard or plant materials that need less individual care. Later chapters will deal with low maintenance design in site layout, grading, the selection of materials, and construction.

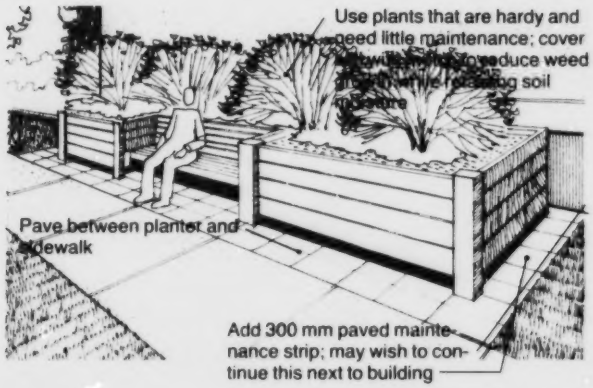

Use plants that are hardy and need little maintenance; cover
Pave between planter and sidewalk
Add 300 mm paved maintenance strip; may wish to continue this next to building

Fig 11. Ways in which this planter and bench combination can be made to look better and be maintained more easily.

"FIT" BUILDING TO SITE. Unique or difficult site conditions should have a strong bearing on building design. Sites with considerable topographic variation may best be developed by using buildings such as split levels that can "fit" into the existing site. Building and site layouts should both respect and take advantage of tree stands or significant rock outcrops. This will make the project more attractive and, usually, less expensive. For more details on grading and matching the housing unit to the site, refer to *Site Landscape for New Housing*, (Ottawa: Canada Mortgage and Housing Corporation, 1980, NHA 5176-1).

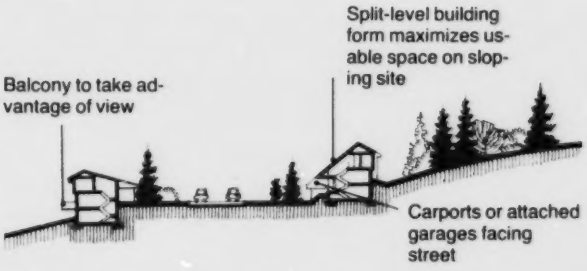

Split-level building form maximizes usable space on sloping site
Balcony to take advantage of view
Carports or attached garages facing street

Fig 12. An example of how building location and form can be designed to complement the site's topography.

SITE PLANNING FOR ENERGY CONSERVATION. The higher costs of oil have prompted designers to pay more and more attention to energy conservation in building design and site planning. For example, regional and climatic conditions will dictate the optimum building orientation for solar access and the location of landscape materials to modify seasonal wind extremes and snow deposits. For further information on energy conservation, refer to *The Conservation of Energy in Housing*, (Ottawa: Canada Mortgage and Housing Corporation, 1981, NHA 5149).

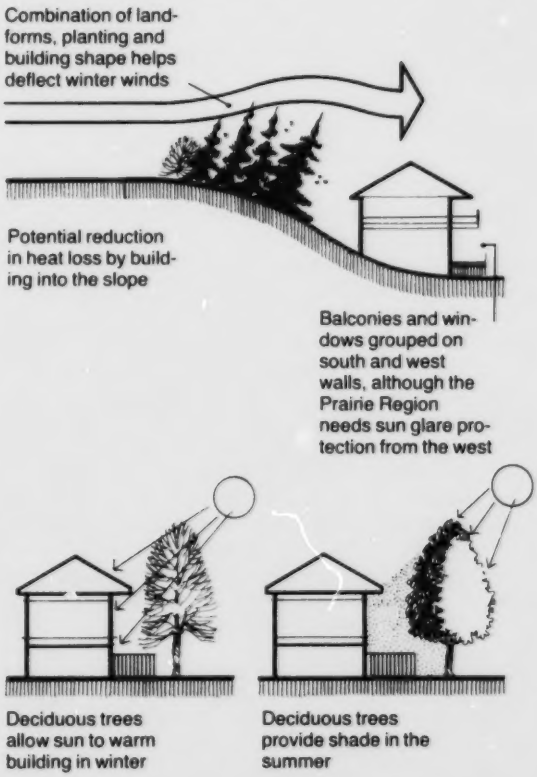

Combination of landforms, planting and building shape helps deflect winter winds
Potential reduction in heat loss by building into the slope
Balconies and windows grouped on south and west walls, although the Prairie Region needs sun glare protection from the west
Deciduous trees allow sun to warm building in winter
Deciduous trees provide shade in the summer

Fig 13. Examples of site landscape features that help to conserve energy.

SITE PLANNING FOR BARRIER FREE MOVEMENT. More and more Canadian designers are ensuring that sites are readily accessible to disabled persons. If the necessary site elements are included in the initial construction, barrier-free movement will be provided at little or no extra capital cost; this matter will be discussed in more detail in Sections 2.3 and 2.4.

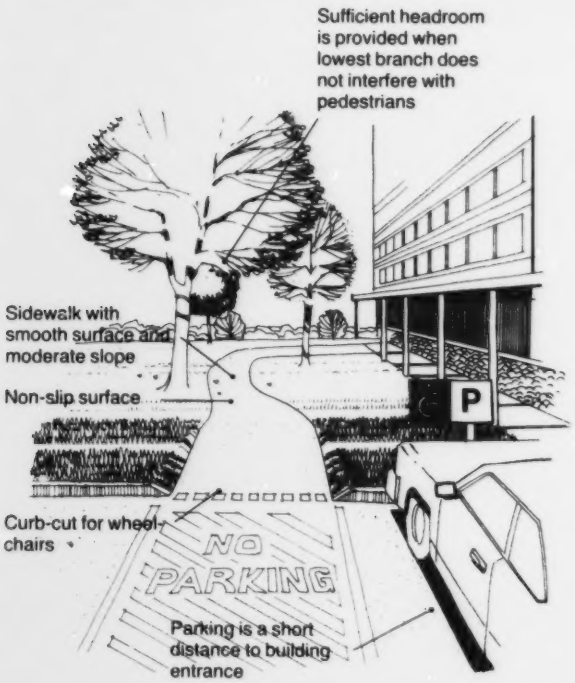

Sufficient headroom is provided when lowest branch does not interfere with pedestrians
Sidewalk with smooth surface and moderate slope
Non-slip surface
Curb-cut for wheel-chairs
NO PARKING
P
Parking is a short distance to building entrance

Fig 14. An example of barrier-free site development. Source: *Guidelines for the Design of Outdoor Spaces for the Physically Handicapped*, City of Toronto Planning Board.

INTEGRATION OF MAJOR DESIGN COMPONENTS. A housing project site development evolves after a number of overlapping design considerations have been looked at; the placement of one site feature should not cause unnecessary problems for the remainder of the site. For example, utilities, whether above or below ground, should be carefully integrated with the site plan to minimize maintenance problems during construction and in the long term. Other examples of site design problems to be avoided include awkward building and site relationships, overuse of retaining walls and steps, and restriction of planting or other landscape development because of underground utilities.

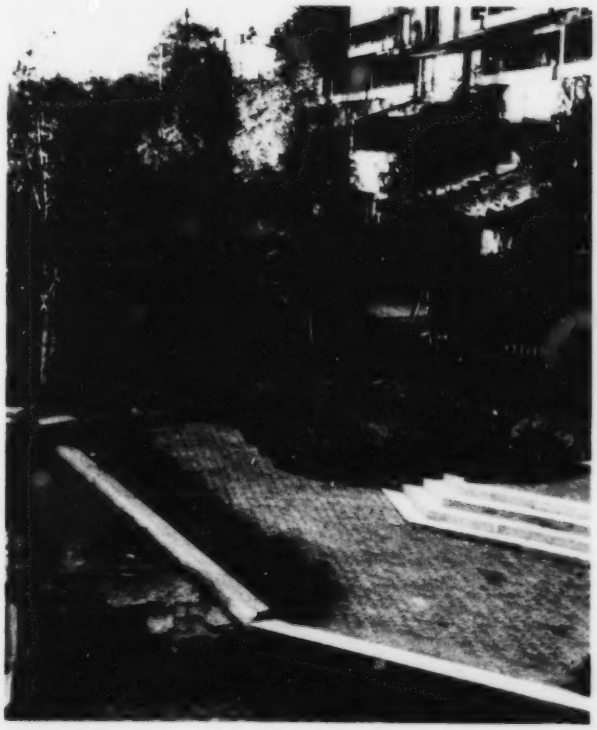


Fig. 15 A successful coordination of site development components, including grading, site layout, hard and plant materials.

INCOMPLETE SITE DEVELOPMENT VERSUS "SHELL LANDSCAPE". When site development costs must be kept low to meet market requirements, a "shell landscape" should be considered. This provides for all layout and grading needs and includes the functional hard and plant materials needed to stabilize site areas and provide some aesthetic appeal. This should be considered a minimum level of site construction for any development. A plan should be given to future owners and residents so that they can complete their "shell landscape" by adding the missing hard and plant materials in the designated locations. Incomplete site development occurs when a major feature, such as a drainage swale or a required walkway, is left out to save funds. This usually displeases residents and brings down the property's potential market value.

Fig. 16 An example of "shell landscape" that meets the functional needs of the site development. More trees and shrubs are to be planted later.

INTRINSIC VALUE OF COMPETENT SITE DEVELOPMENT INVESTMENT. This is perhaps the most obvious, yet the least understood, of the design principles of site development. The value of well-designed housing projects increases with time and pays dividends in lower maintenance costs and eventual marketability. When comparing similar projects, those with superior landscape development appreciate in value and rapidly recover their higher initial capital costs, if any.

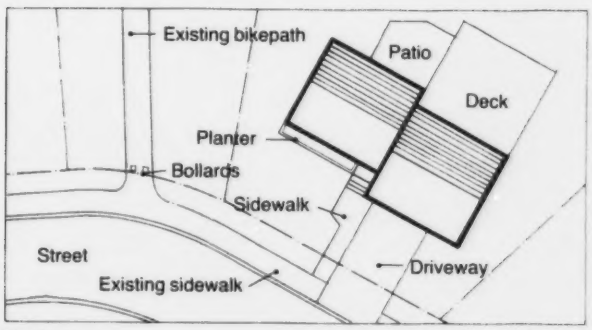
Fig. 17 This example of good site development includes functional site layout, planting for pedestrian control, visual screening and a suitable level of maintenance.

1.3 LANDSCAPE DESIGN COMPONENTS

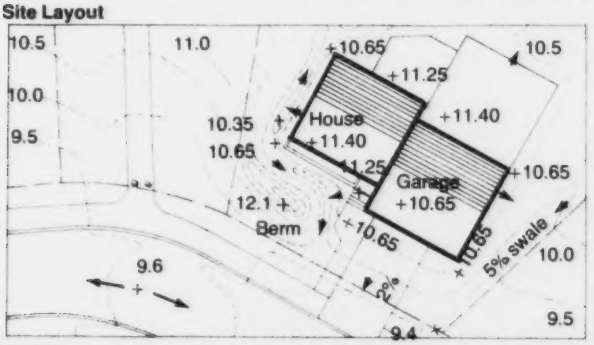
Landscape design comprises site layout, grading, hard materials and plant materials; these will be dealt with in detail in Chapters 2, 3, 4 and 5 respectively. Construction and maintenance are covered in Chapter 6.

The four major components of landscape design can be briefly defined:

- *site layout* deals with the basic organization of site facilities and uses, as well as their relationship to each other and the housing units
- *grading* provides surface drainage, established elevations for facilities and site landforms
- *hard materials* involves the selection of materials for paved surfaces, walls, fences, furniture, lighting and similar "hard" site features
- *plant materials* concerns the selection and location of trees, shrubs, lawns and groundcovers to meet certain functional, aesthetic and maintenance objectives of the "soft" landscape.

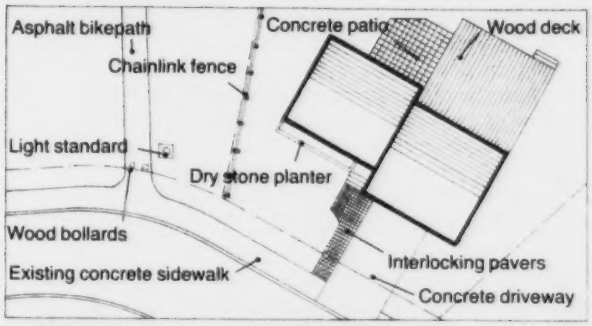


Site Layout

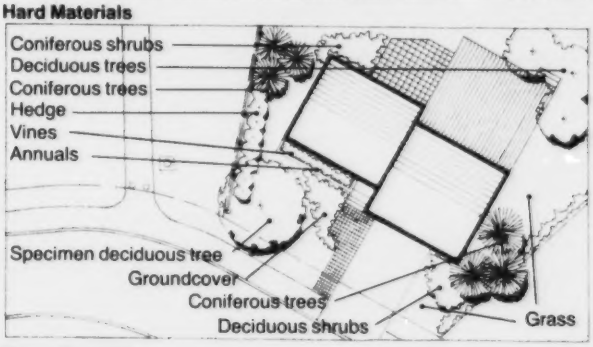


Grading

Fig. 18 Examples of site layout and grading.



Hard Materials



Plant Materials

Fig. 19 Examples of hard materials and plant materials.

1.4 DESIGN PROCESS AND SITE ANALYSIS

The purpose of the design process is to find the optimum solution to each site development problem. First the problem must be defined; then it should be supplemented by further research related to peculiar regional, community and site conditions. This data is then analyzed for the major physical, social, cultural and environmental factors that will influence the site development plan. Alternative solutions may be prepared in schematic form and evaluated according to their relative success in meeting the site development goals. The preferred conceptual solution is then used for production of the detailed design.

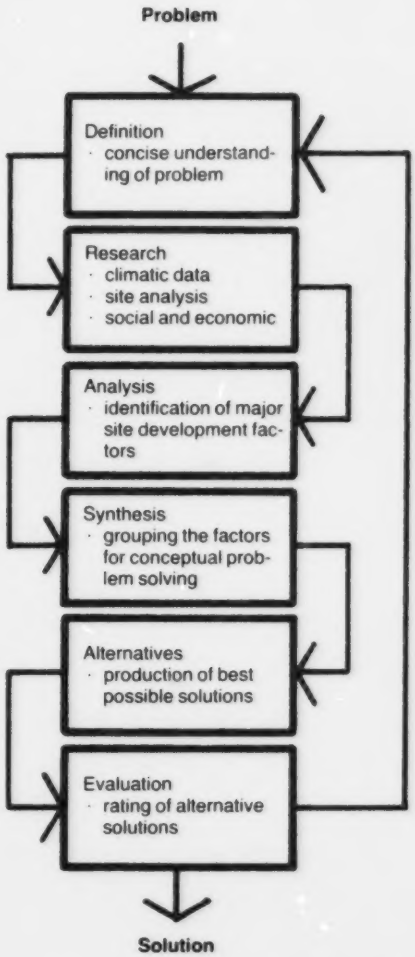


Fig. 20 The design process as related to landscape design.

Of the steps mentioned above, the analysis of site data is often the most critical and complex. Site analysis is the process of determining development potential through the collection, analysis and interpretation of site data. Generally, the site's amenities and a detailed site analysis is commonly used to determine the most cost-effective way to exploit a site's amenities and potential within its regional, social and ecological context. Both on-site and off-site factors must be considered when gathering data for the preparation of a site analysis (see Figure 21 for details). When a builder is considering several parcels of land for a housing project, it is common practice to conduct a site analysis of each one before selecting the most suitable site.

Fig. 21 Typical site analysis information.

On-Site Factors

1. Topography
   - high and low points on site
   - percentage of slope (particularly slopes in excess of 10 per cent)
   - major landforms and special topographic features.
2. Hydrology
   - natural drainage features (streams, ponds, wetlands, flood plains)
   - drainage swales and direction of surface run-off
   - ground water (depth, seasonal variation).
3. Soils
   - topsoil quality (fertility, texture)
   - foundation-related characteristics (subsoil type, bearing capacity, stability)
   - drainage and erosion characteristics
   - sub-surface geology (depth to bedrock, type)
   - special features (rock outcrops).
4. Vegetation
   - location, size and species of major trees and shrubs (including trunk diameter, height and spread of trees)
   - unique plant specimens or habitat groupings.
5. Legal and administrative restrictions
   - regional and local plans
   - zoning, bylaws and codes
   - approval process and special requirements that might apply to the site (density, fencing, façade materials).
6. Microclimate
   - orientation of slopes to sun and wind
   - projecting or exposed site areas.
7. Existing man-made site features
   - structures
   - roads, utilities, rights-of-way and easements.
8. Special features
   - visual qualities (good or poor views from site)
   - historic buildings or sites
   - environmentally sensitive areas.

Off-Site Factors

1. Adjacent land use (type and impact).
2. Eyesores, noise hazards.
3. Community facilities (distances to schools, shopping, parks).
4. Road systems and utilities.
5. Regional factors.
   - social and economic.
6. Climate
   - seasonal temperatures
   - local prevailing winds
   - snow and drifting patterns
   - rainfall and maximum storm levels
   - hours of sunshine.

Site analysis data normally can be collected from municipal and other administrative offices, site surveys, existing plans and aerial photographs. It is recommended that all existing plans be verified by a site inspection due to the possibilities of misinformation and recent changes to the site. The relevant information should then be recorded on a map of appropriate scale. Special expertise on soil engineering, hydrology, vegetation and the environment may be required to complete the site analysis for larger and more complex sites.

Site information is extremely useful in guiding the design and development of a project, but it must be interpreted and understood to be useful. One map is usually enough to illustrate and summarize the important on-site and off-site factors for a typical housing project. However, with complex sites it may be necessary to use separate plans to analyse such special aspects as soils or vegetation, before a "site analysis summary" is carried out. This summary plan would simply condense all relevant information into categories like buildable and non-buildable zones; examples of detailed information to be included are:

- soil conditions
- site access and present location of utilities
- recreation and amenity potential (existing trees, special features)
- visual qualities and views to be preserved
- easements and other legal restrictions
- visual or noise pollution (origin and levels)
- climate control considerations (solar, wind, snow, rain)
- site features to be retained or removed (trees, buildings, land forms).

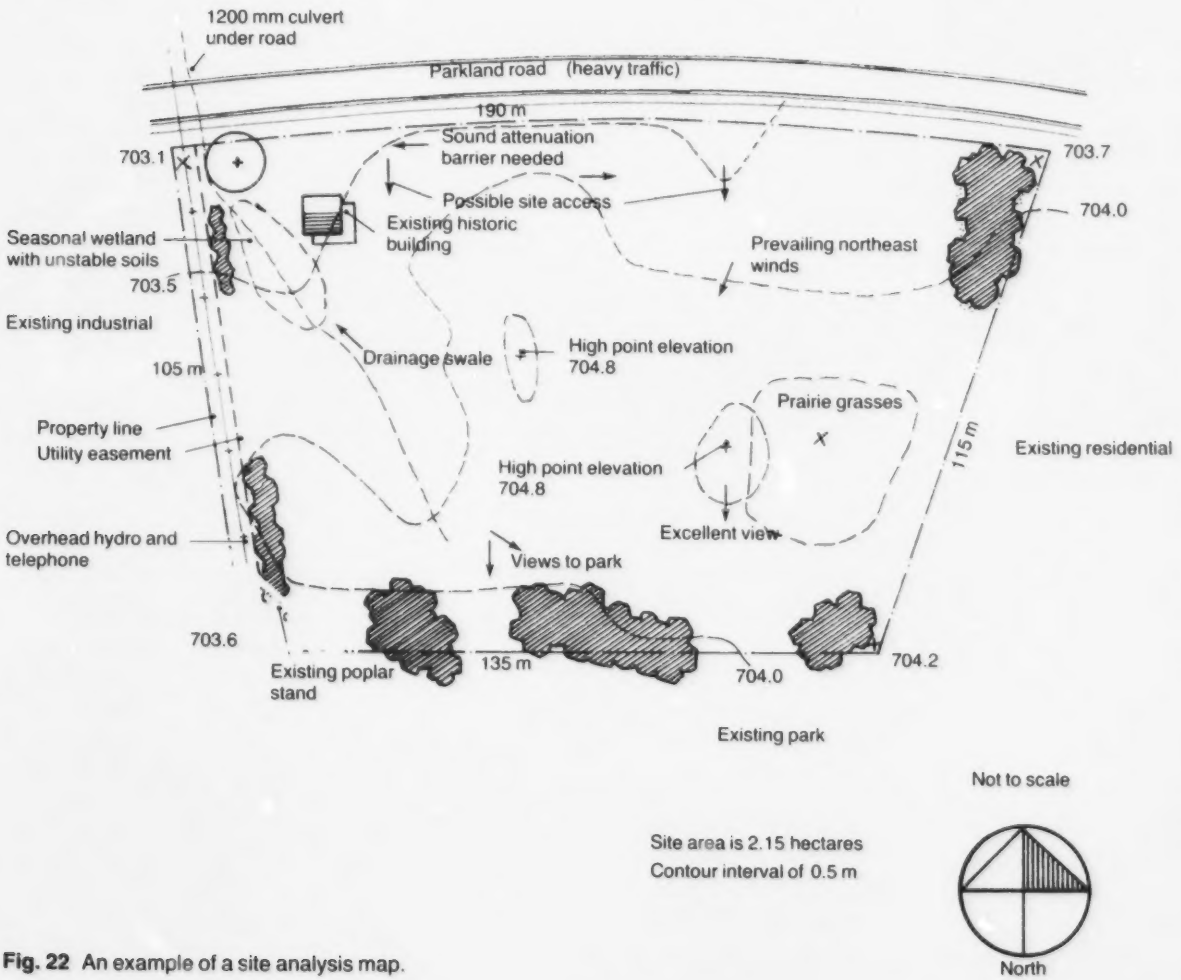


Fig. 22 An example of a site analysis map.

1.5 SUMMARY CHECKLIST

Are influences on the project, such as legal restrictions, market analysis, budgets and community infrastructure, understood? Has the appropriate information been collected? (Refer to Section 1.1)

Have regional factors, such as the climate, peculiar social and economic conditions, and the availability of materials and contractors, been considered in relation to site development? (Refer to Section 1.1)

Have the following functional requirements been incorporated in the site program: access, circulation, parking, storage, utilities, services, drainage, garbage and communal recreational areas? (Refer to Section 1.2)

Does the site program include design goals like low maintenance design and "shell landscape"? (Refer to Section 1.2)

Is the inter-relationship between the landscape design components of site layout, grading, hard materials and plant materials fully understood? (Refer to Section 1.3)

Has a thorough site analysis been conducted, which gathers all relevant on-site information, such as topography, hydrology, soils, microclimate, legal restrictions, existing features and vegetation? (Refer to Section 1.4)

Does the site analysis include the important off-site factors of adjacent land use, climate, regional concerns, road systems and community facilities? (Refer to Section 1.4)

Have the site analysis factors been interpreted and summarized on a plan? (Refer to Section 1.4)

CHAPTER 2 — SITE LAYOUT

A site layout is normally done at the same time as decisions are made about the other landscape design components of grading, hard materials and plant materials. However, for simplicity, this chapter will concentrate on the various aspects of site layout design. Site layout is essentially concerned with obtaining the best two-dimensional relationships between private, communal and public spaces, as well as with the organization of site features and circulation. As the previous chapter illustrated, site design should respond to housing project influences, such as legal restrictions, community infrastructure, functional site needs and design goals. Conceptual solutions to a site's layout design may then be produced, so that optimum site relationships can be obtained by determining the location of specific activity areas, circulation routes, site features and all other elements necessary for the landscape design to function properly and be visually pleasing.

2.1 CONCEPTUAL SITE LAYOUT

To clarify the following explanation of layout design, it is necessary to first provide brief definitions of private, communal and public space. "Private space" refers to the exterior space of a housing development, to which only the individual resident has access; when it is located immediately adjacent to the dwelling unit, it is often referred to as an "outdoor living area". "Communal space" denotes project site areas that are accessible and available to all residents and visitors. This space may be used in a variety of ways, vehicular parking, for instance, or pedestrian circulation, or for recreation. "Public space" refers to municipal or other public property, usually a street right-of-way, that can be used by residents, visitors and the general public. Landscape design within this public space must be carefully coordinated with local bylaws and should complement neighbouring areas.

The purpose of the conceptual site layout is to produce alternative preliminary design solutions from which the optimum relationship between different site uses will evolve. A common method of beginning to resolve the best relationship between major site areas and uses is by using "bubble diagrams", such as the one illustrated in Figure 23.

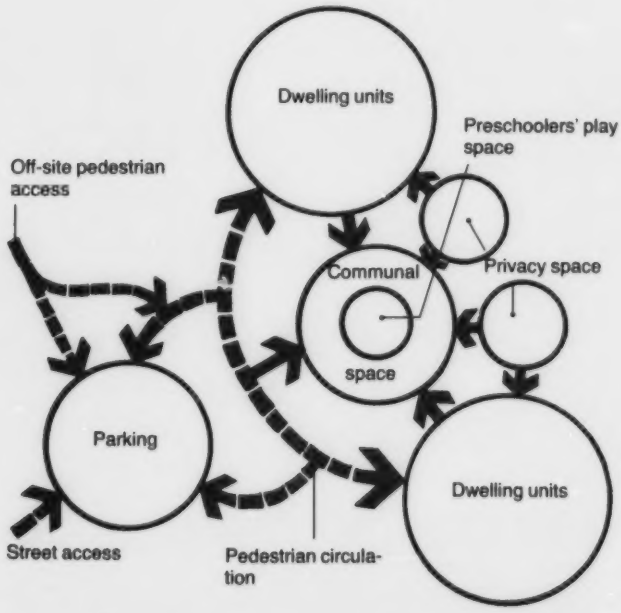


Fig. 23 This diagram illustrates the relationships between site uses within a typical multi-family housing development. This type of preliminary conceptual study is often referred to as a "bubble diagram".

The next step in the conceptual site layout is to determine the overall arrangement of buildings and site uses, by reviewing what the needs of the eventual residents might be, budget limitations, existing site characteristics and the proposed architectural development. Usually several alternative solutions are investigated before one is selected which offers the greatest number of cost benefits. A conceptual site layout should illustrate the general locations of and relationships between the following:

- vehicular access, circulation and parking
- pedestrian circulation and entrances to buildings
- existing and proposed buildings and major site features
- private, communal and public spaces
- recreational areas and access to them
- visual control (screening)
- possible major grading features (berms, swales, retaining walls, steep slopes)
- adjacent land uses.

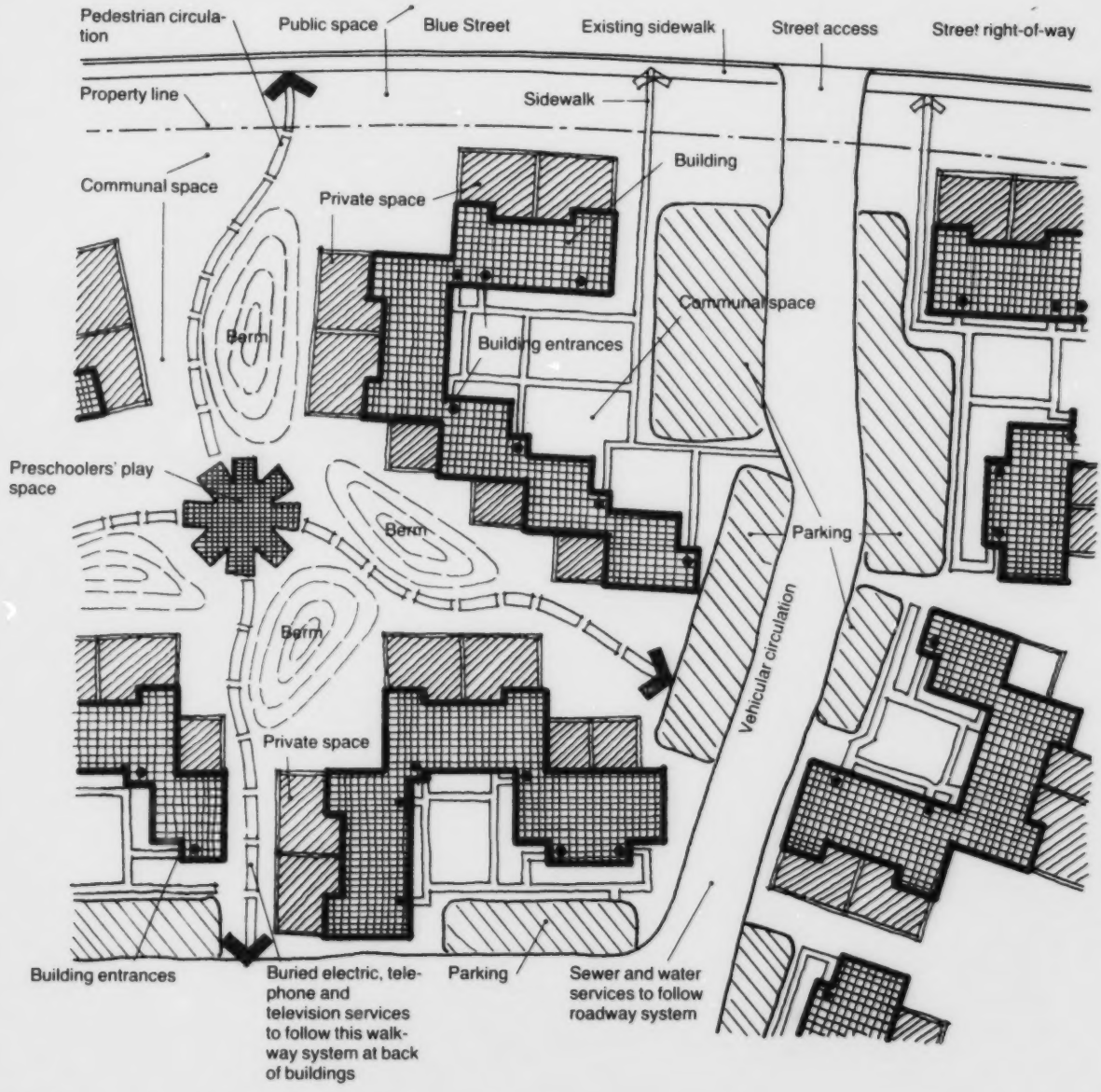


Fig. 24 Part of a typical conceptual layout plan.

All underground utilities, such as sewer, water, telephone and electricity, require special consideration during both the conceptual and the detailed site layouts. The eventual detailed design of the sewer and water systems are normally the responsibility of an engineer, although final grading around exposed valves, manholes and catch basins is frequently coordinated by the landscape architect. The relationship between site activities, buildings and utilities should be resolved at the conceptual stage so that incompatibilities are minimized. At this stage, too, it is important to foresee what repair and maintenance costs might have to be carried out after the project has been completed; for example, utilities should not be placed beneath site features which are difficult or expensive to replace.

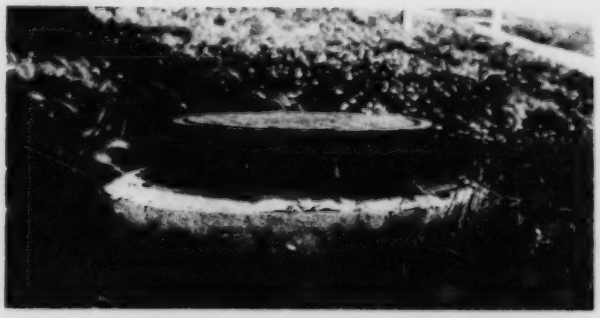


Fig. 25 This manhole was not successfully integrated into the layout and grading design; it is unsightly, a hazard to pedestrians, and causes additional maintenance.

2.2 DETAILED SITE LAYOUT

The detailed site layout refines the selected conceptual layout into a finished design, drawn to a convenient scale. The detailed design is influenced by the special design requirements of private, communal and public space, each of which will be discussed further after the typical site layout plan illustrated by Figure 26.

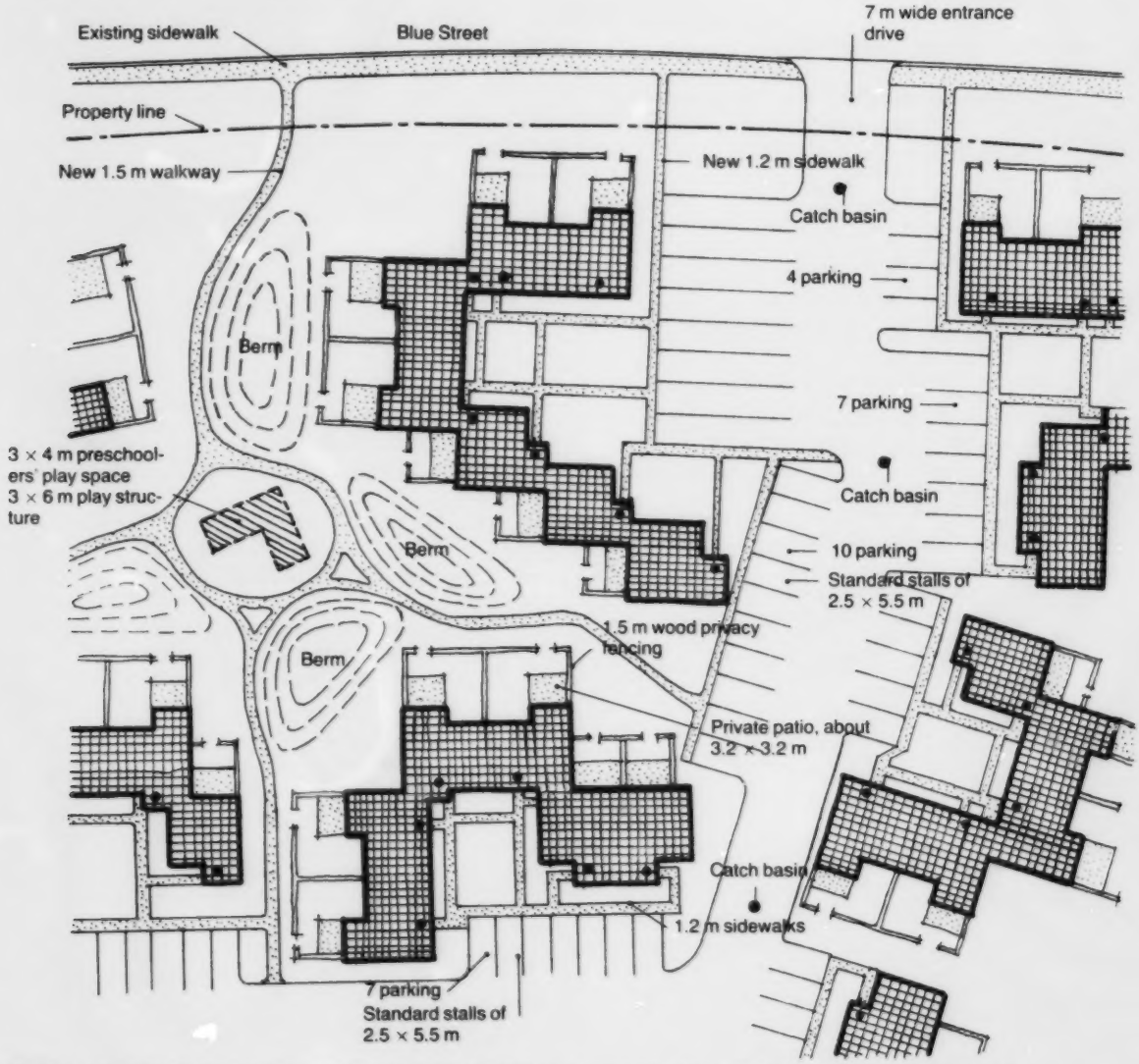


Fig. 26 A typical site layout plan, which has more detail than a conceptual layout plan would include, does not become a completed "working drawing" until the dimensions and locations of both hard and plant materials are added.

The design of private spaces is very important to most residents since they will spend a great deal of time in these outdoor areas. Depending on regional factors, private spaces can typically take the form of:

- backyards adjacent to a large communal space
- balconies
- terraces
- courtyards
- roof decks.

The following are suggested design criteria for private spaces as outdoor living areas within a multiple-family housing project (*Outdoor Living Areas: Advisory Document*, (Ottawa: Canada Mortgage and Housing Corporation, 1980, NHA 5329)):

- direct access from the dwelling unit
- a minimum dimension of five metres and an area equal to one half the dwelling floor area, or 45 m², whichever is smaller
- an area at grade or closely related to grade
- includes screening and climate control
- accessibility to disabled persons
- provision for easy maintenance.

The layout and design of a private space at grade must reflect realistically the type and amount of maintenance required. A common problem is that small backyards or courtyards are designed with lawn areas of less than 10 m², the resident then has to rent or buy a lawnmower to maintain this small patch of grass. Alternative solutions would be to replace the lawn area with a combination of paving and larger plants, or to designate one person to maintain both the communal and private areas.

Fig. 27 These individual outdoor living areas are closely integrated with the communal space while still providing a certain amount of privacy for each dwelling unit.

Communal space generally makes up the largest portion of a multiple-dwelling project site and may include:

- access roads and parking
- pedestrian walkways
- garbage collection areas
- storage areas
- buffer zones between areas used for different activities
- amenity areas (active recreation areas like a play space for preschool children, and passive recreation like seating areas).

Fig. 28 This communal open space has been designed to serve as a noise buffer between the rows of housing and their individual outdoor living areas behind the fencing. Since this area is seen from an access road, it lends an attractive visual character to the housing project.

Communal space must be carefully planned so that it is well integrated with both private space and public space; it should be developed with the needs of the eventual occupants in mind. Existing amenities may be incorporated into the site layout for practical and aesthetic reasons. Creating new site amenities, such as a combination planting and seating area, will give pleasure to residents while improving the project's attractiveness and saleability. People naturally prefer a diverse and interesting landscape over a monotonous one, and the layout of communal space should take this into account. Communal space should be easy and inexpensive to maintain, but should not restrict residents from using it.

Fig. 29 An example of communal space that provides an easy-to-maintain, hard-surfaced area for recreational activity. Centralized seating has been provided for residents, and the plants create more privacy and shade. The lighting makes the area safer at night.

Since public space is often the first thing a visitor sees on a site, special consideration should be given to its layout and maintenance. Ideally, public space should become a visual extension of communal space, where property lines, such as a street right-of-way, are not readily recognized. The development of the public space on a project site is often influenced or controlled by municipal or other regulations, although maintaining a street right-of-way is undertaken as an extension of the communal space.

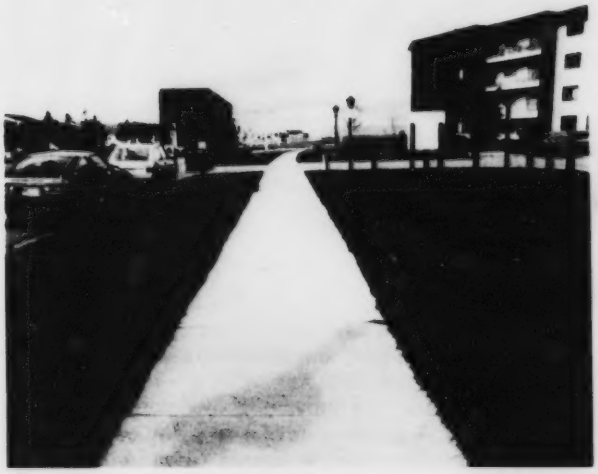


Fig. 30 An example of a public space which includes both a street right-of-way and a municipal public sidewalk. Placing trees on the street would help to alleviate the barren appearance.

2.3 VEHICULAR ACCESS AND PARKING

A special consideration when planning for access roads and parking areas is their possible use by firetrucks, ambulances and other emergency vehicles. Appropriate turning radii and width of access roads, as well as easy access to all units, must be provided. Sometimes fire lanes are designed to limit access to emergency vehicles; therefore, removable bollards or other barriers are placed at the fire lane entry to prevent other traffic from coming in. Generally, municipal bylaws and other planning regulations indicate the dimensions, siting and detailed design of fire lanes and other requirements regarding emergency vehicle access. Snow-removal equipment and garbage collection vehicles may also require minimum space for access and turning.

Since parking areas are an essential part of all housing developments, it is important that their layout be functional, simple, safe and attractive. A parking area can create a bad impression if it is not properly designed.

There are several ways of providing parking and no single best solution; some possibilities are:

- in the front of a unit; in an individual laneway or a communal parking bay
- in a garage or carport, sometimes in the rear yard, as is often found on the Prairies
- in a parking structure above or below ground
- in a parking area at the end of a row of attached units, or separated from the units in small scattered lots.

Fig. 31 Attached garages and carports are convenient; in this case the garages are on a lower level because of the site's topography.

Fig. 32 A good example of a conveniently placed carport. It is both near to and at the same level as the entrance to the dwelling.

Topography and the building form have a strong bearing on where parking areas are placed. If the purpose of the parking is to help visitors, the lot should be located close to the building's entrance. Topography is important because, for safety's sake, parking areas should be relatively level, and yet be sloped enough for proper drainage. Building form and the population density also affect where parking is located. Placing individual parking next to detached dwellings and condominiums at grade is often done if there is space available; it is a good marketing feature. Rental accommodation, such as high-rise apartments, often has parking further from the units because of higher densities and a general shortage of space; marketability is not as great a concern for rental projects.

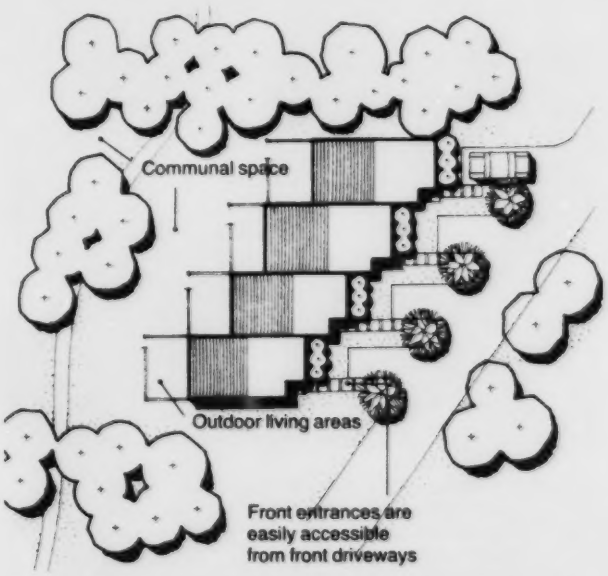


Fig. 33 Parking may be provided on a front driveway next to the unit if bylaws and other regulations permit. This is a common solution for rental townhouses and condominiums at grade.

Detached garages
Entrance walkway
Communal garages and parking lots commonly require a longer walking distance to individual dwellings

Fig. 34 Detached individual garages for each dwelling unit are one way of providing covered parking; another alternative, when the site area is more restricted, is to use wider garages in which four to ten vehicles can be parked.

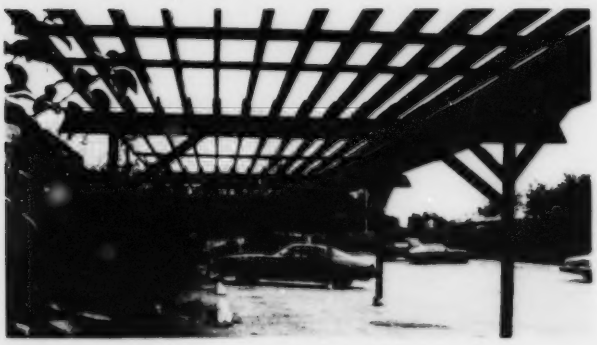


Fig. 35 This trellised structure is a variation of the communal garage or carport; it enhances the project's visual character but does not provide as much protection as a carport.

One solution for sites without pleasant views or open space is to orientate the units inwards, towards the centre of the site. This layout creates the effect of an interior court, with parking on the site's perimeter.

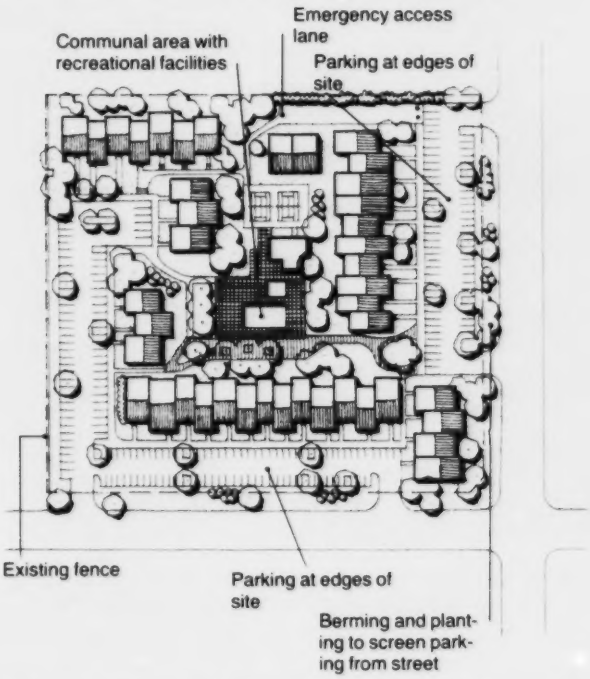

Emergency access lane
Communal area with recreational facilities
Parking at edges of site
Existing fence
Parking at edges of site
Berming and planting to screen parking from street

Fig. 36 An example of an "inward orientated" housing project, in which parking is placed on the edges of the site to allow the dwelling units to face towards a central communal area.

In general, parking areas should be screened from driveways and private spaces; this can be accomplished by making use of earth berms, vegetation, changes in grade, walls and fences.

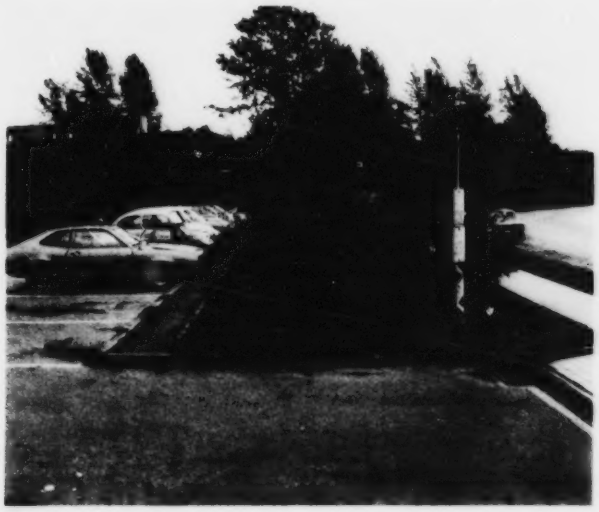


Fig. 37 An example of an effective visual screen, achieved by berming and planting between a road and parking lot.

Another way of achieving a harmonious site is the "outward orientated" arrangement of parking in the centre of the site while the dwellings look out. To ensure pedestrian safety, short walking distances and a more pleasant environment, it is better to use several smaller parking lots than one large one.

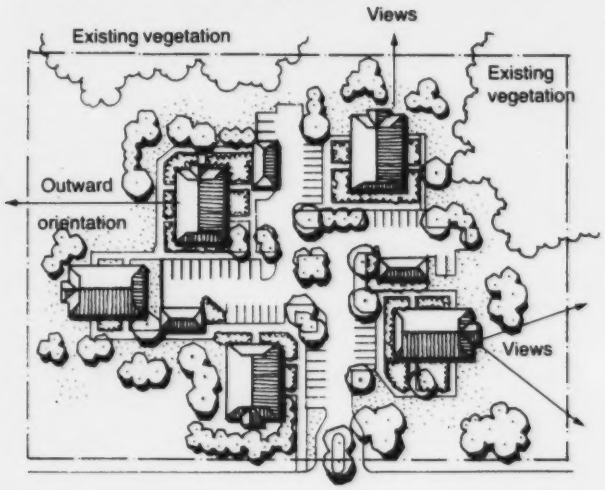


Fig. 38 An example of an "outward orientated" housing project. Centrally located parking allows convenient access to each unit, while units face outwards to uninterrupted views of nearby amenities.

Fig. 39 This centrally located parking area allows the units to face outwards; however, the large expanse of asphalt and the lack of landscape features drastically reduce its visual attractiveness.

Garbage collection and snow removal, other important factors for the layout of a parking lot, are discussed in Sections 2.6 and 2.7. For additional information about parking, refer to *Parking Areas: Advisory Document*, (Ottawa: Canada Mortgage and Housing Corporation, 1980, NHA 5239).

2.4 PEDESTRIAN CIRCULATION

A special consideration for both vehicular and pedestrian traffic is barrier- free access for disabled people. Some parking stalls, solely for the disabled, should be located as close to the building's entrance as possible, preferably within 30 metres. There should be direct and barrier-free access from the parking stalls to the building, with curb cuts and ramps wherever necessary. The parking spaces should be hard-surfaced, with a minimum width of 3.1 metres and a maximum cross slope of 1:100. They should be identified by appropriate signs and pavement markings, and the building's management should ensure that they are reserved for disabled persons. If the parking space is used by someone who is not disabled, the local police should be called to issue a parking ticket. For additional design details, refer to *Building Standards for the Handicapped 1980*, (Ottawa: National Research Council of Canada, 1980, NRCC 17669).

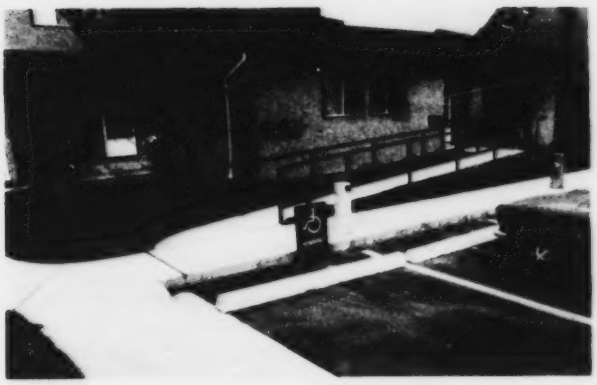


Fig. 40 Reserved parking stalls for disabled persons should be close to the building's entrance and have easy access to it.

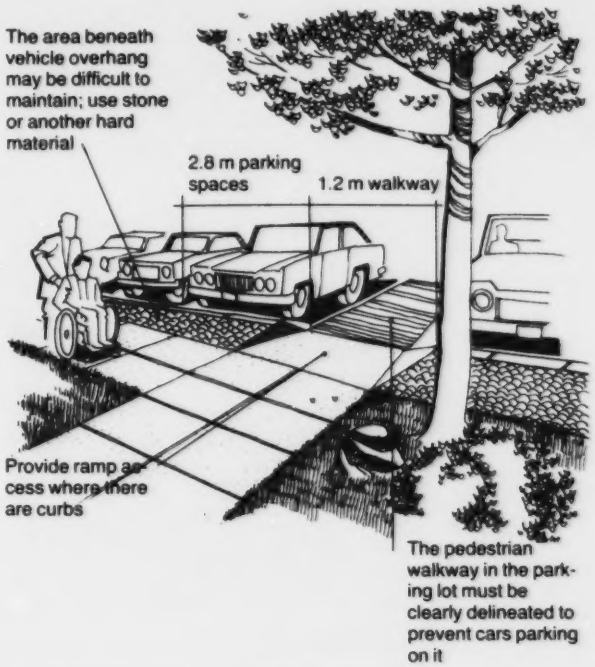

The area beneath vehicle overhang may be difficult to maintain; use stone or another hard material
2.8 m parking spaces
1.2 m walkway
Provide ramp access where there are curbs
The pedestrian walkway in the parking lot must be clearly delineated to prevent cars parking on it

Fig. 41 Ramps and curb cuts should be built from parking areas to sidewalks. (Source: *Barrier Free Site Design*, Washington, D.C.: U.S. Department of Housing and Urban Development, 1975).

Pedestrian circulation is of fundamental importance on a site. Its design must take account of the ease of vehicular access, parking, buildings and recreational facilities. *Residential Site Development, Advisory Document*, (Ottawa: Canada Mortgage and Housing Corporation, 1981, NHA 5364) recommends that pedestrian routes should:

- be connected to existing sidewalks, walkways or open pathways
- provide a convenient connection between each unit and parking lots, garbage disposal areas, public sidewalks and communal open space
- be free of barriers, so that wheelchairs and baby carriages can use all routes
- be removed from vehicular routes
- be safe during the day and at night
- offer views wherever possible and take advantage of natural and man-made amenities.

Lighting is an important part of the pedestrian circulation system. Lights should be placed at intersections, crosswalks and grade changes and should be designed to be in scale with pedestrians and to blend with the surrounding buildings and site. For details on the relationship of lighting and security, see Section 2.8.

Fig. 42 An example of a well-designed sidewalk with adequate lighting provided for night-time security.

Well-designed walkways can help to dissuade pedestrians from taking short cuts. When paths are worn on lawns or plant beds, it may be necessary to re-examine the site's walkways. One solution is to replace worn areas with more durable materials, such as interlocking pavers (this is discussed in detail in Section 4.2). Another remedy is to plant dense shrubs or erect fences, walls or other barriers so that pedestrians are forced to keep to the walkways.

Walkways should be wide enough to accommodate the anticipated number and types of users. Generally, they should be a minimum of 1.2 metres wide and not exceed the maximum gradients (as listed in Section 3.2). Their surface should be firm and stable and have a non-slip finish. Steps should be avoided wherever possible, and ramps are recommended to overcome grade changes at curbs and building entrances. Barrier-free access always should be provided to allow the greatest diversity of people to move safely, independently and unhindered through the site.

2.5 AMENITY AREA

Space outside the dwelling unit that is intended for the recreation and enjoyment of the residents is usually referred to as an amenity area. It can consist of the previously mentioned private and communal spaces.

Play spaces for children should be situated within a communal amenity area so that they can be observed from adjacent family units. Fencing or planting can be put up as a noise buffer and safety barrier. It is important that play spaces should be specifically designed for the age-groups who will use them. They should incorporate a variety of play activities to hold the children's interest. Play spaces should provide areas for creative, cognitive, social and physical play, and seats for supervisors or parents. If such areas are well planned, they can be very attractive. For further information on the layout and design of play spaces for children, refer to Canada Mortgage and Housing Corporation publications entitled *Play Spaces for Preschoolers*, (1978, NHA 5138) and *Play Spaces for School-Age Children, 6 to 14 Years of Age*, (1980, NHA 5418).

Roof decks on higher-density buildings or garages may also form part of a site's amenity area. They provide space for passive recreation, such as seating, sunbathing and viewing, and, if proper safety precautions are taken, play spaces may be used and active sports played on the decks. For additional information, see *Roof Decks —Design Guidelines*, (Ottawa: Canada Mortgage and Housing Corporation, 1979, NHA 5220).

Fig. 43 Play spaces are valuable additions to communal amenity areas in family-orientated housing projects.

2.6 GARBAGE COLLECTION AND REMOVAL

A garbage storage area is possibly the most difficult element to locate satisfactorily on a site. There is substantial controversy as to the preferred system of garbage storage and collection, and municipalities recommend widely divergent procedures for individual housing projects. After learning what particular storage system and collection vehicles are required, the following site design factors should be considered:

- garbage storage areas should be conveniently accessible to residents and service vehicles
- for front pick-up vehicles, a clear and straight approach of no less than 10 m is necessary. Avoid overhead interference from wires, lights or tree branches
- garbage storage areas should not be placed too close to housing units because of the nuisance of odours and noise. Swinging doors on garbage storage areas can be an inconvenience to adjacent site uses
- garbage storage areas should be screened from view by enclosed fencing, grading, or plant material
- walkways should connect dwelling units to garbage storage areas. Children should have easy access because frequently it is they who have to carry the garbage bags to the storage area. A ramp or stairs next to a medium or tall storage bin will prevent children leaving garbage bags on the ground
- the design of the storage area should deter animals from entering it.

Where garbage collection areas are combined with parking lots, space must be allowed in which trucks can manoeuvre, so that long and difficult back- up movements are unnecessary. A minimum turning radius of 10.5 m should be provided on any roadway used by service vehicles. Garbage collection areas should be placed in such a way that a parked service vehicle will not block access to the other parking areas. For additional screening details, see Section 4.3.

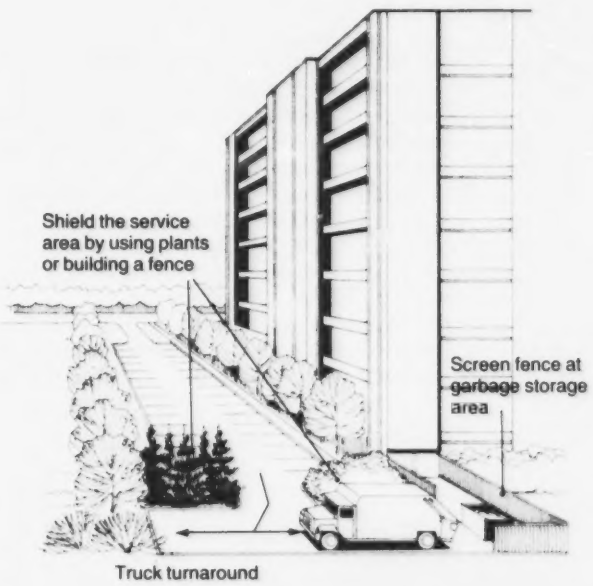


Fig. 44 Where possible, garbage collection areas and parking lots should be separated, and adequately screened from housing units.

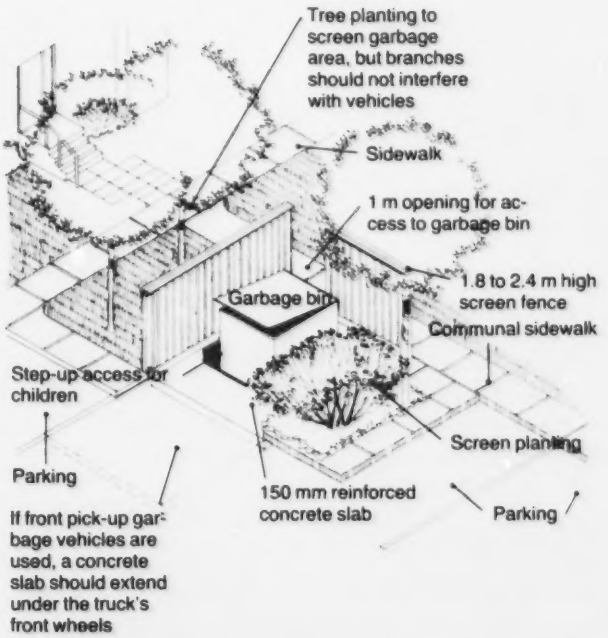

Tree planting to screen garbage area, but branches should not interfere with vehicles
Sidewalk
1 m opening for access to garbage bin
1.8 to 2.4 m high screen fence
Garbage bin
Communal sidewalk
Step-up access for children
Screen planting
Parking
150 mm reinforced concrete slab
Parking
If front pick-up garbage vehicles are used, a concrete slab should extend under the truck's front wheels

Fig. 45 A garbage bin area that is screened with a fence and planting.

2.7 SNOW STORAGE AND REMOVAL

Bylaws regarding the storage and removal of snow vary greatly across Canada. Consequently, each site development should be designed to satisfy local bylaws and to suit local climatic conditions. Snow storage areas can include open spaces adjacent to roads and parking areas. Another option is road medians and boulevards with carefully placed plants that do not interfere with snow storage. However, since road sand and salts will harm plants and grasses, snow mixed with sand and salt should be stored only on hard-surfaced areas, or collected and removed from the site. If clean snow is provided for children's outdoor play, like sliding, it should be placed far away from vehicular traffic.

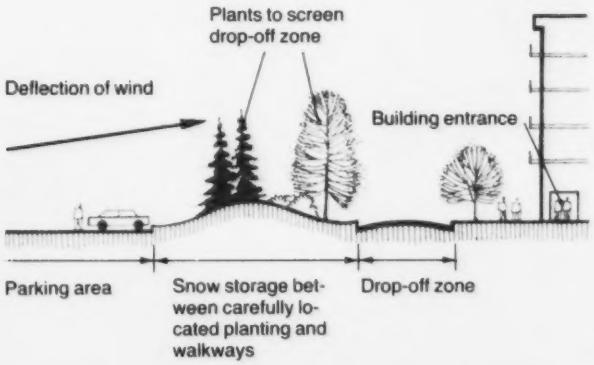


Fig. 46 An example of a snow storage area between a parking lot and a drop-off zone at a building entrance.

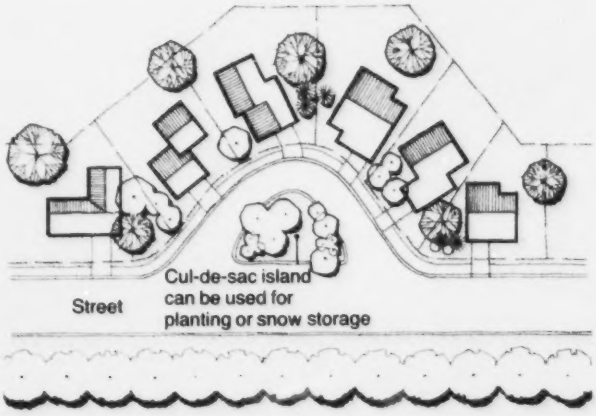


Fig. 47 If space is limited, medians and cul-de-sac islands may be used for snow storage.

The surface material and condition of the road or parking areas greatly affect the ease with which snow can be collected and stored or removed from the site. Since asphalt curbs are frequently damaged by snow blades, it is recommended that they not be used where snow is being removed. Speed bumps, too, are a hindrance to snow removal equipment.

Fig. 48 Speed bumps may cause problems for both snow-removal equipment and surface drainage.

Removing snow from sidewalks and pathways is easier if planting, fences and walls are not immediately adjacent to the edges of the walks. Enough space should be provided to permit the snow to be cleared by small tractors or hand-powered equipment; otherwise, snow accumulation may cause safety and maintenance problems.

Fig. 49 Snow removal from this walkway is extremely difficult because of the fences on either side and the other obstacles.

2.8 SECURITY, VANDALISM AND LIGHTING

An effective method of preventing vandalism of play spaces, parking areas and communal space is to ensure that there is adequate lighting and surveillance from surrounding dwellings. Housing project management should formally ask for the assistance of residents in preventing vandalism, including surveillance and participation in establishing rules and regulations that pertain to activities within their housing development.

Benches, play structures, bollards and outdoor lighting should be designed and placed to achieve the maximum security with the minimum maintenance. Permanent site furniture should have concrete footings and anchor bolts to make it immovable. It is advisable to have regular maintenance checks so that petty vandalism and normal wear and tear can be attended to before serious repairs or replacements are necessary. For additional information on maintenance programs, refer to Sections 6.4, 6.5 and Appendix C.

Fig. 50 A poor layout and grading design, substandard construction and a lack of maintenance have produced this unsightly parking area.

2.9 SUMMARY CHECKLIST

Have the site use and building relationships been considered during the conceptual layout of the private, communal and public space? (Refer to Section 2.1)

Have building and site servicing requirements been coordinated with the site layout design? (Refer to Section 2.1)

Does the conceptual site layout take into account vehicular access, pedestrian circulation, recreation areas, utilities and major grading features? (Refer to Section 2.1)

Has the size and location of private space been specified in the detailed site layout? (Refer to Section 2.2)

Has the type and amount of maintenance required for private and communal spaces been considered during the site layout? (Refer to Section 2.2)

Has the layout of communal space satisfied the various functional, recreational and aesthetic interests? Does the layout of street tree planting and the design of other public space create an attractive appearance and conform to municipal bylaws and other regulations? (Refer to Section 2.2)

Were the following kept in mind during the placement of parking facilities: emergency vehicles, functional use, safety, general attractiveness, existing topography, tenure and project density? (Refer to Section 2.3)

Are parking stalls for disabled people provided near the building's entrance? Are walkways and building entrances free of barriers? (Refer to Section 2.4)

Are suitable private and communal amenity areas provided, including children's play spaces? (Refer to Section 2.5)

Has the upkeep of private and communal amenity areas been adequately considered? (Refer to Section 2.5)

Are garbage collection and storage areas placed where they will not interfere with other site uses? (Refer to Section 2.6)

Are snow storage areas suitably located to allow snow to be cleared easily without damaging pavement, plants and lighting? (Refer to Section 2.7)

Does the site's layout provide adequate means for residents to keep watch on communal space to reduce vandalism and ensure greater security? Is lighting provided at key locations? (Refer to Section 2.8)

CHAPTER 3—GRADING

Grading is the process of reshaping the topography of a site to accommodate buildings and to assist drainage, circulation systems and existing plants and trees. As the "third dimension" of landscape design, grading is the vertical element that makes complete the two-dimensional site layout. To be accomplished efficiently and competently, it is normally done at the same time as the site layout but, for simplicity and clarity, this chapter will focus just on the various aspects of grading.

3.1 FUNCTIONAL AND AESTHETIC ASPECTS

Grading is undertaken for both functional and aesthetic reasons. Some of these are:

- to ensure that surface water drains away from structures, and that the site is free of excess surface run-off
- to create suitable subgrade conditions for utilities, structures, roads, walkways and activity areas
- to create useable spaces by providing appropriate surface slopes
- to create earth berms for the control of wind and noise, and to emphasize space
- to help conserve existing vegetation
- to create pleasant views and screen unsightliness
- to create variety and interest within the site by creating different landforms. These may include toboggan runs, play mounds, or playing fields
- generally, to coordinate the building and site components of the housing project.

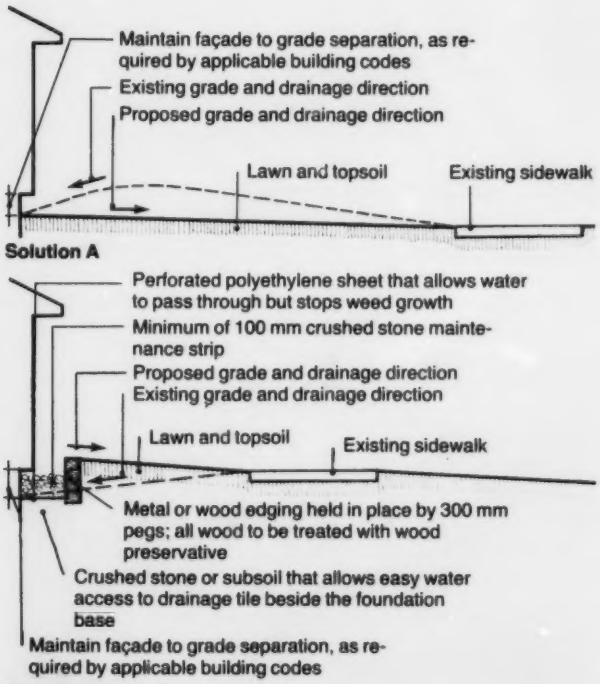

Maintain façade to grade separation, as required by applicable building codes
Existing grade and drainage direction
Proposed grade and drainage direction
Lawn and topsoil
Existing sidewalk
Solution A
Perforated polyethylene sheet that allows water to pass through but stops weed growth
Minimum of 100 mm crushed stone maintenance strip
Proposed grade and drainage direction
Existing grade and drainage direction
Lawn and topsoil
Existing sidewalk
Metal or wood edging held in place by 300 mm pegs; all wood to be treated with wood preservative
Crushed stone or subsoil that allows easy water access to drainage tile beside the foundation base
Maintain façade to grade separation, as required by applicable building codes
Solution B

Fig. 51 Draining surface water away from buildings is one of the most important functions of grading. Solution A is appropriate when the surrounding site can be regraded; Solution B should be adopted when the existing site layout and elevations force the corrective action to take place next to the building.

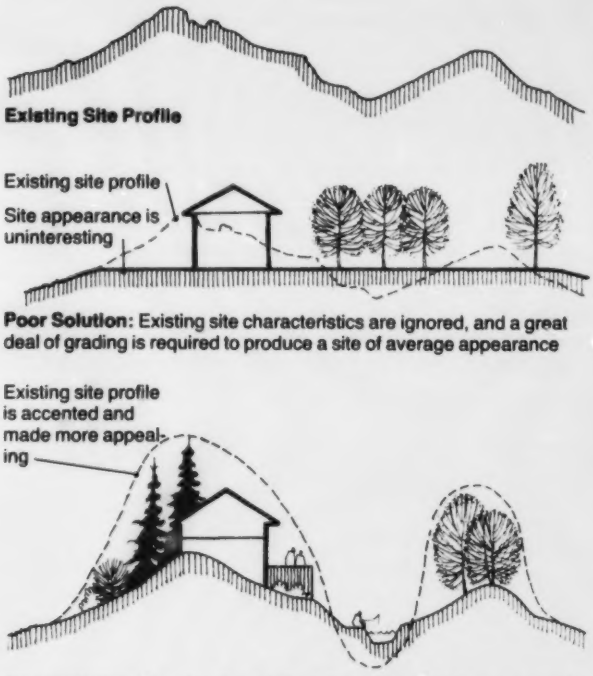

Existing Site Profile
Existing site profile
Site appearance is uninteresting
Poor Solution: Existing site characteristics are ignored, and a great deal of grading is required to produce a site of average appearance
Existing site profile is accented and made more appealing
Good solution: By using the existing site profile, a minimum amount of grading is required to produce a dramatic-looking site

Fig. 52 Grading changes can be minimized by matching the existing site profile to the proposed development concept.

3.2 GRADIENTS

Gradients or slopes for driveways, walkways, parking lots and recreational areas are a very important design feature. Suggested gradients for common site situations are listed in Figure 53; provincial, municipal and other local planning requirements must be followed. Slopes or gradients are expressed as a ratio of the length of rise to the length of run; for example, 1:10 is the same as 10 per cent and 1:50 is the same as 2 per cent.

To have the correct gradients for sidewalks and entrance drives is particularly important during slippery winter conditions. As a rule-of-thumb, in relatively flat regions which have frequent snow and ice, cross slopes should not exceed 2 per cent, and slopes running lengthwise should not exceed 7 per cent. Where circumstances warrant it, adding extra steps or ramps at the building is usually a better solution than exceeding the maximum gradient.

For safety's sake, sidewalks should always have non-slip surfaces and should not be located in drainage swales or low parts of the site. This will make it easier for pedestrians during heavy rains, and will reduce difficulties with ice and snow in wintertime. A sidewalk should be designed with a suitable lengthwise slope and cross slope to allow it to drain properly.

	Lengthwise Slope (%)			Cross Slope (%)		
	Min.	Max.	Optimum	Min.	Max.	Optimum
Paved Driveways	1.0	12.0	2.0	1.0	6.0	2.0
Parking	1.0	6.0	2.0	1.0	6.0	2.0
Walkways	2.0	10.0	2.0	1.0	2.0	1.5
Paved Service Areas	2.0	6.0	2.0	2.0	6.0	2.0
Patio/Sitting Areas	1.0	2.0	1.5			
Pedestrian Ramps	1.0	10.0	2.0			
Lawns	2.0	5.0	2.0			
Grass Swales	2.0	10.0	2.0			
Mowed Banks	2.0	33.0	2.0	2.0	20.0	5.0
Unmowed Banks with vegetation	2.0	40.0	2.0			

Fig. 53 Suggested gradients. Note: the gradients listed as maximum are extremes; therefore, retaining walls, terraces and steps should be considered. For design requirements for disabled people, consult *Building Standards for the Handicapped 1980*, (Ottawa: National Research Council of Canada, 1980, NRCC 17669).

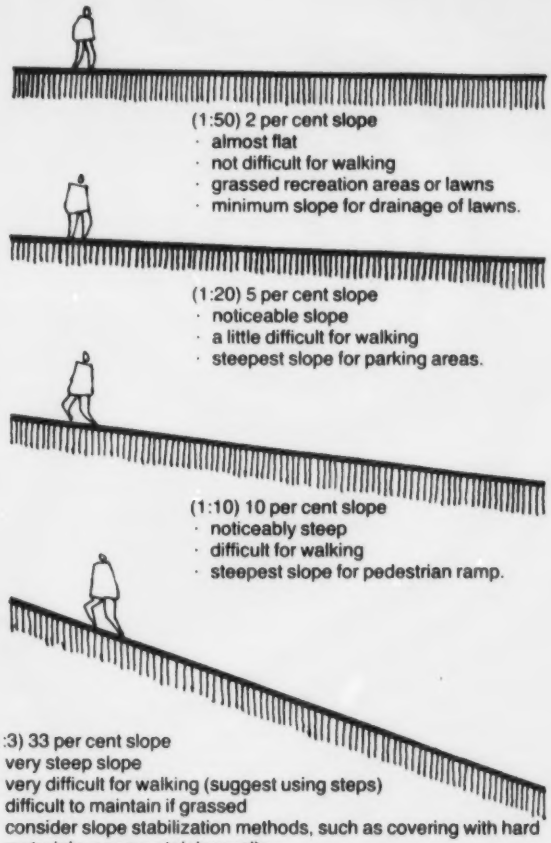

(1:50) 2 per cent slope
· almost flat
· not difficult for walking
· grassed recreation areas or lawns
· minimum slope for drainage of lawns.
(1:20) 5 per cent slope
· noticeable slope
· a little difficult for walking
· steepest slope for parking areas.
(1:10) 10 per cent slope
· noticeably steep
· difficult for walking
· steepest slope for pedestrian ramp.
(1:3) 33 per cent slope
· very steep slope
· very difficult for walking (suggest using steps)
· difficult to maintain if grassed
· consider slope stabilization methods, such as covering with hard materials, or use retaining walls.

Fig. 54 Examples of commonly used gradients. Note: 10 per cent (1:10) slopes and steeper are especially dangerous in winter conditions.

Fig. 55 This driveway is a typical example of how a gradient is critical to site use and safety. A driveway should not slope down towards the garage because it makes it difficult to remove snow and may lead to flooding; in this type of driveway, expensive heating of the pavement and drain may be necessary.

3.3 GRADING PLAN

Most site developments require some reshaping of the existing ground surface to accomplish proper grading. This reshaping is usually planned and illustrated on a technical drawing called a grading plan, which is used by the designer to calculate and then design three-dimensional changes to the surface of the site. One of the basic purposes in developing a grading plan is to ensure that surface water drains away from buildings and is efficiently removed from the site, either by swales and ditches or by a subsurface storm-sewer system.

Fig. 56 One function of grading is to create land forms, such as this swale, to dispose of surface water run-off.

It is necessary to get the topographic information about the existing site before a grading plan can be prepared. Much of this information may have already been collected during the site analysis, and it should be summarized on a site plan at a suitable scale, usually 1:500, 1:1000 or 1:2000. A detailed site survey should be conducted, and it is recommended that the following data be illustrated on the plan:

- topography (high and low points shown by existing spot elevations and/or contours)
- property lines (locations and elevations)
- elevations of roads, walkways, steps and curbs
- drainage structures, such as manholes, catch basins, drain inlets and sewers (surface and invert elevations)
- surface drainage patterns (including run-off to and from adjacent property)
- easements and utility lines
- first-floor elevations of existing buildings
- major natural features (existing vegetation, rock outcroppings, unstable slopes).

Other information that will be necessary in the preparation of a grading plan is:

- soil and subsoil drainage characteristics (for run-off variations due to soil permeability)
- precipitation intensity and frequency (for determining the potential total of run-off water)
- water-table fluctuations (to determine the need for an underground drainage system).

One method of representing site topography is spot elevations. These elevations are shown at critical locations on the grading plan; for example, the tops and bottoms of both retaining walls and flights of steps. For the most part, existing topographic data furnished from a site survey is illustrated by this method.

Another way of representing a three-dimensional land surface on the grading plan is by means of contours. A contour is a line representing a constant elevation on the land surface. Contour lines are used to indicate changes between existing topography and proposed grading. Depending on the scale of the plan, contours are usually shown at vertical intervals of 0.5 metres. Existing contours are normally shown as dashed lines and proposed contours as solid lines. The use of spot elevations and contours is usually necessary in order to clearly illustrate surface gradients and landforms.

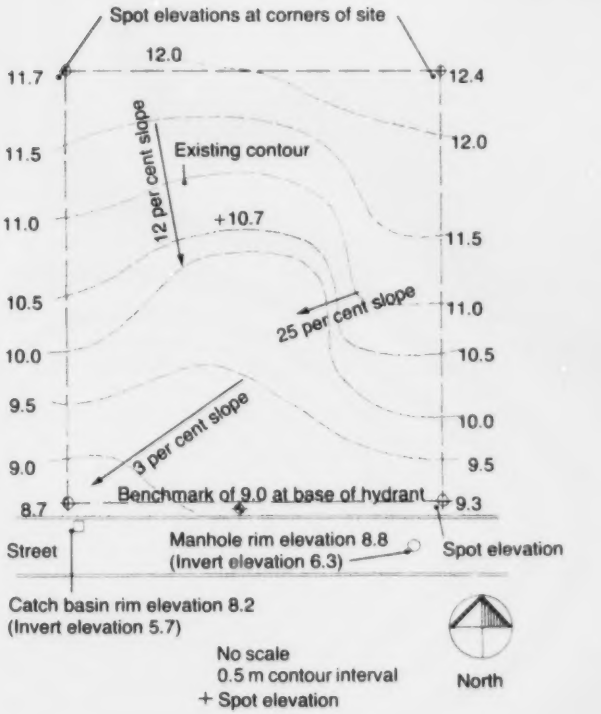


Fig. 57 An example of existing grades, showing both contours and spot elevations.

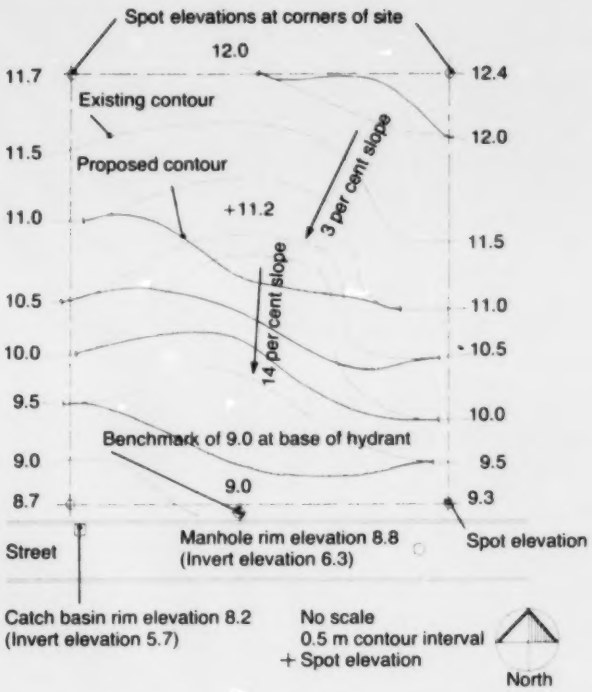


Fig. 58 An example of a grading plan showing proposed contours that are "tied" into corresponding existing contours.

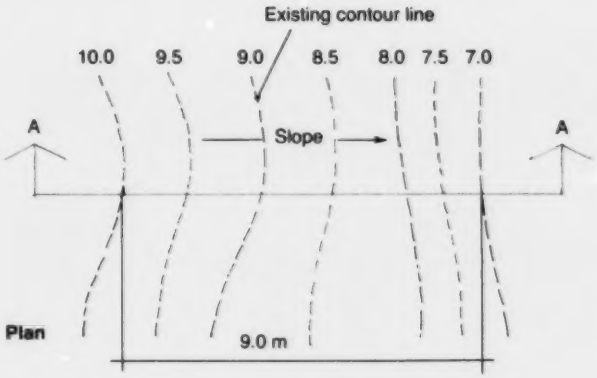
To determine surface gradients by using a grading plan involves the simple relationship of three components:

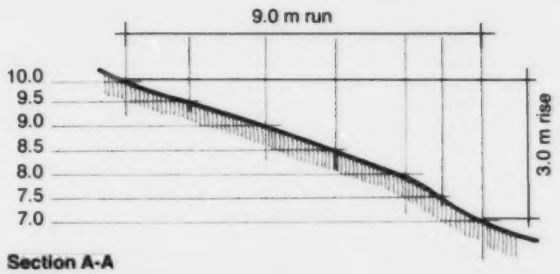
- gradient or slope
- horizontal change in distance (run)
- vertical change in elevation (rise).

To determine one of these three, the designer must know the other two:

- slope = rise ÷ run
- run = rise ÷ slope
- rise = slope ÷ run.

Altering site slopes produces different design solutions for the designers. Generally, minimum and maximum gradients must be met for all site surfaces, and the designer has to try different layout and grading combinations until the optimum site arrangement is determined.





Section A-A

Slope = rise ÷ run
Slope = 3.0 ÷ 9.0 = 33.3 per cent
Slope = ratio of 1:33

Fig. 59 Slope is an expression of the vertical change in elevation (rise) in relation to the horizontal change in distance (run). It may be expressed as a ratio or a percentage.

It is always desirable to preserve and reuse the existing topsoil layer of a site; it means a better quality site development and will reduce construction costs. The grading plan can be utilized to specify a place where the topsoil can be stockpiled, or the plan may indicate site areas from which the topsoil does not have to be removed.

Another important application of the grading plan is to illustrate areas of soil cut and fill. From the proposed grading design, the designer can calculate the amounts of soil cut (soil to be removed) and soil fill (soil to be added) that will occur as a result of it. It is always advantageous to try to balance cut and fill quantities in order to reduce the time and cost of bringing in or removing material from the site during construction.

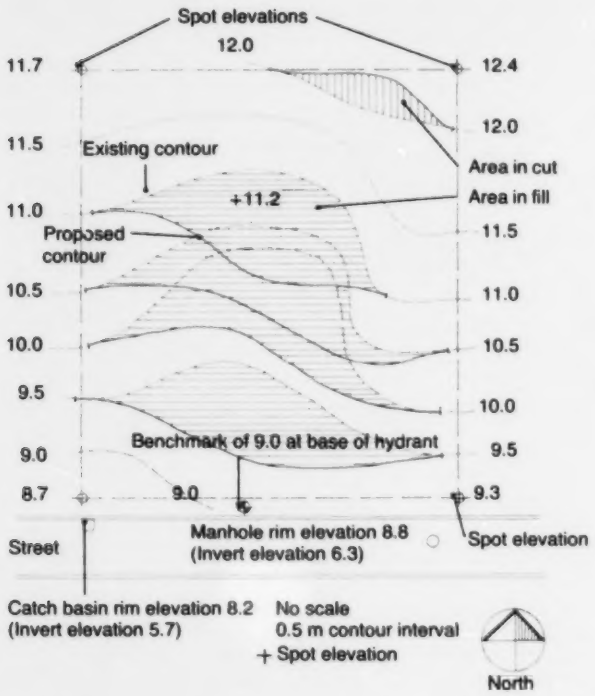


Fig. 60 An example of illustrating areas of cut and fill on a grading plan.

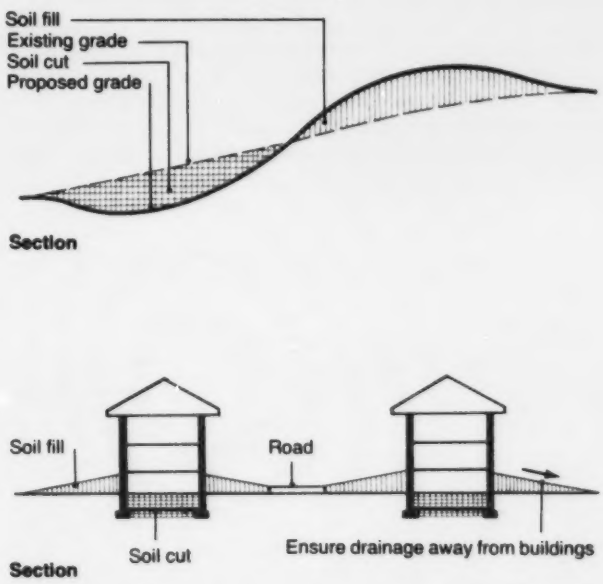


Fig. 61 Conceptual examples of balancing cut and fill.

Fig. 62 An excess of soil cut was kept on site to make this toboggan and ski hill.

3.4 WALLS AND STEPS

When gradients become as steep as 1:3, site grading features, such as retaining walls, stairs, ramps and tree wells, should be used. Retaining walls can increase the usable level space on a site. One method of accomplishing this is to build several low walls to create a terraced effect.

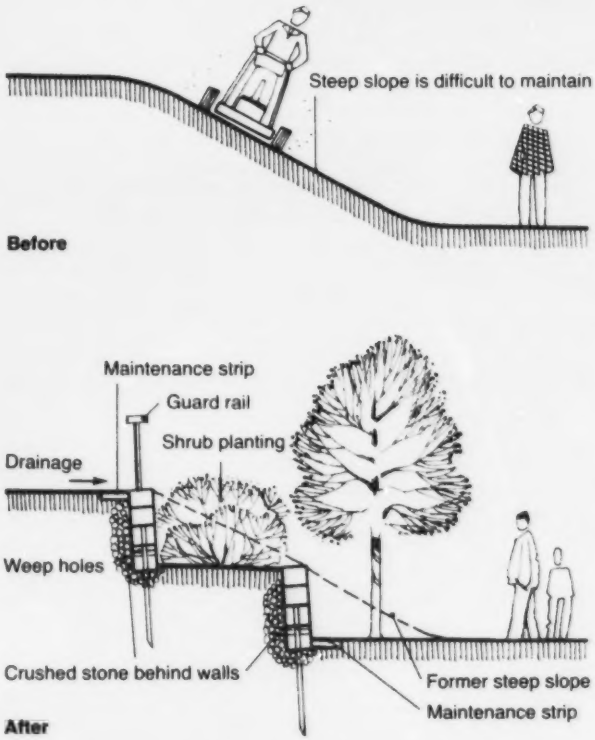


Fig. 63 An example of a terraced slope that provides more usable level space while easing maintenance.

Retaining walls can be built from a number of different materials. The design and choice of materials will depend on economic factors, the height of the wall, and the weight of material being held back. Common construction materials are wood, concrete and stone. Designs for walls of reinforced concrete or others which are over 1.5 metres in height should be approved by an engineer.

Retaining wall footings and foundations should be capable of withstanding frost heave, which usually means that they should be constructed below the maximum depth of frost penetration. Also, retaining wall foundations should rest on stable and undisturbed soil or compacted crushed stone. Releasing of drainage water and freezing pressure from behind the wall is achieved by providing crushed stone behind the wall and weepholes along the bottom of the wall at 1.5 metre intervals. However, some municipalities require that drainage from behind the wall be piped into a storm sewer system, instead of weep holes. Guard rails should normally be provided on walls over 600 mm in height; check local bylaws for requirements on their use and construction.

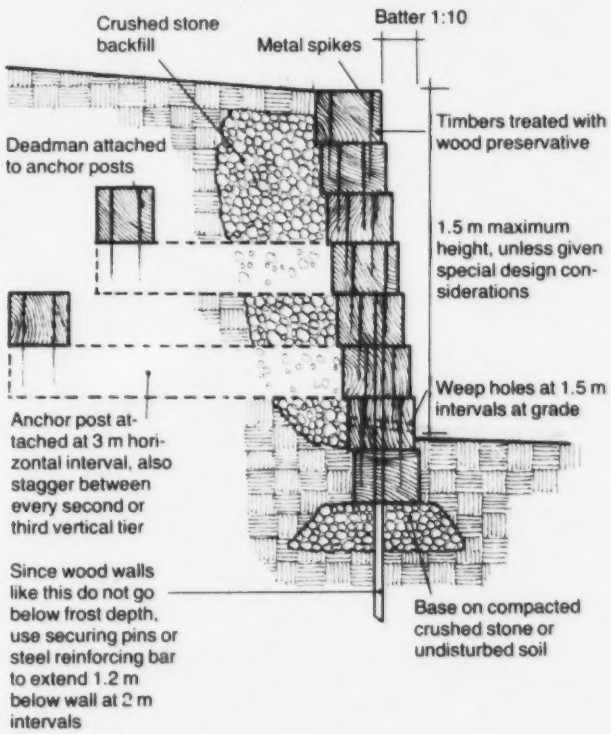

Crushed stone backfill
Metal spikes
Batter 1:10
Timbers treated with wood preservative
Deadman attached to anchor posts
1.5 m maximum height, unless given special design considerations
Weep holes at 1.5 m intervals at grade
Anchor post attached at 3 m horizontal interval, also stagger between every second or third vertical tier
Since wood walls like this do not go below frost depth, use securing pins or steel reinforcing bar to extend 1.2 m below wall at 2 m intervals
Base on compacted crushed stone or undisturbed soil

Fig. 64 An example of a timber retaining wall that may be constructed from railroad ties or rough sawn timbers. Unless the timbers have been previously pressure-treated, they should be painted with a wood preservative on site.

Wooden retaining walls blend well with the natural landscape and with most architectural façades. Wood is an attractive material and is available in most parts of Canada. It is the most common material used for retaining walls, and they are usually constructed from railroad ties, or 150 x 150 mm or larger timbers that are rough sawn and pressure-treated with preservative. Walls of this type may last from ten to fifty years before they need to be replaced, depending on the wall's height, soil conditions, climate and construction practices. If there is any chance of residents being in contact with the wall, a wood preservative, other than creosote, should be used to prevent hands and clothes being stained with oil. (It should be noted that most railroad ties are treated with creosote.) Timber walls are usually two to three times cheaper than concrete walls of the same height, and are generally easy to construct. The maximum height for wood retaining walls is usually between 1.0 and 1.5 metres, although well-anchored walls can go as high as three metres if they are properly engineered.

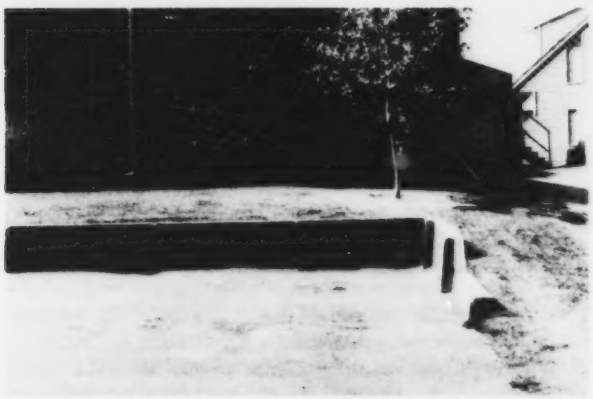


Fig. 65 A simple timber retaining wall used to create a level parking area. Walls of this type should be built with timber that has been pressure-treated with wood preservative to prevent rotting.

Concrete is another common retaining wall material; the design of reinforced concrete walls is the work of a professional engineer. Generally, these walls are very expensive but, under certain soil conditions, may be more desirable than wood or stone. Footings for concrete walls must be below maximum frost depth and seated on either compacted undisturbed soil or compacted crushed stone. Weepholes should be provided to allow for drainage from behind the wall. The exposed face of a concrete retaining wall may be treated by sandblasting or using various forming techniques to make it more attractive. The greatest advantage of concrete retaining walls is their permanence, and well-constructed walls may last for more than a hundred years. Their long-term and inexpensive maintenance adds to their appeal.

Fig. 66 This reinforced concrete retaining wall has been successfully integrated into a low maintenance landscape design; however, a maintenance strip or widening the sidewalk at the base of the wall would have removed the need to hand-trim the lawn next to the wall.

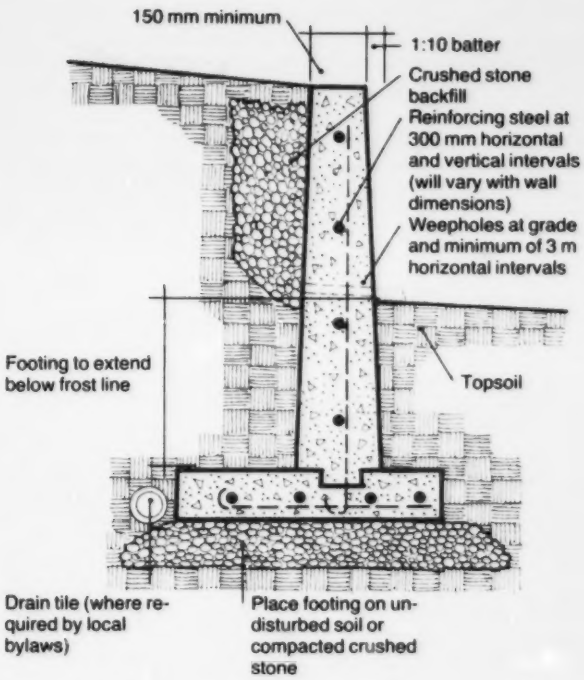

150 mm minimum
1:10 batter
Crushed stone backfill
Reinforcing steel at 300 mm horizontal and vertical intervals (will vary with wall dimensions)
Weepholes at grade and minimum of 3 m horizontal intervals
Footing to extend below frost line
Topsoil
Drain tile (where required by local bylaws)
Place footing on undisturbed soil or compacted crushed stone

Fig. 67 A typical reinforced concrete wall.

Precast concrete retaining walls usually are less expensive than cast-in-place concrete walls, but a limited number of styles and finishes are available. There are height restrictions for precast concrete walls since each section has to be anchored separately. Generally, anchoring is done by burying steel or concrete tie-backs, or "deadmen", into the retained slope. The degree of anchoring required to ensure a safe and permanent wall will vary with the soil conditions.

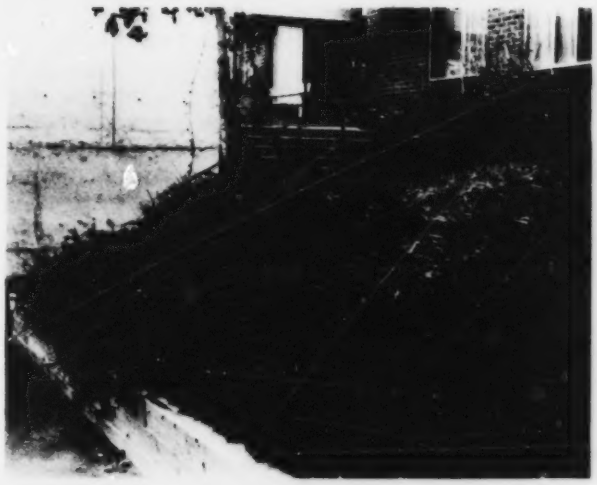


Fig. 68 This precast concrete retaining wall should have been higher, to retain the existing grade more effectively.

There are two methods of building a retaining wall with stone. One is the dry stone wall; the other is the stone and mortar wall, which is harder to construct and more expensive. Their greatest advantages are their stability, permanence and pleasant appearance.

The dry stone retaining wall is most common, and is built without the use of mortar or other binding agent between the stones. To provide stability, it is best to use large stones with a minimum thickness of 100 mm and generally flat sides. The maximum recommended wall height is 1.2 m. As with wood and concrete walls, stone walls should be set on undisturbed soil or compacted crushed stone. Crushed stone should be placed behind the wall to allow drainage and to prevent soil from filtering between the wall's large stones.

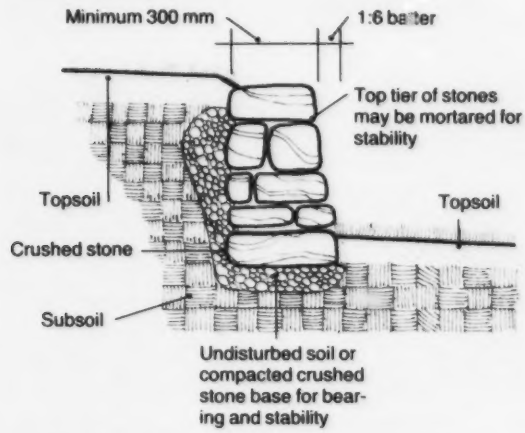


Fig. 69 An example of a dry stone retaining wall.

Retaining walls are also commonly used to preserve trees on the site. If it is determined during the site analysis that some or all of the existing trees are to be retained, they need to be protected both during and after construction. Protection should consist of avoiding excessive grade changes, operating construction equipment carefully, providing suitable slope stabilization where needed, and fencing off sensitive areas; see Section 6.2 for details on construction fencing. Storing building materials or operating heavy construction equipment close to a tree can destroy it because the soil is compacted around the roots.

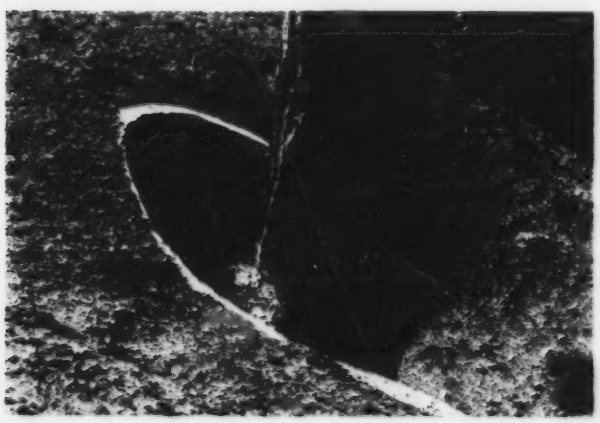
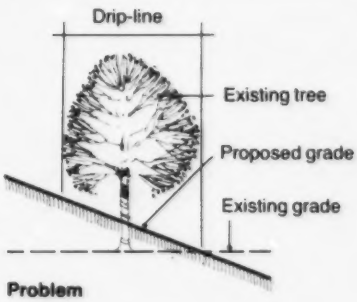
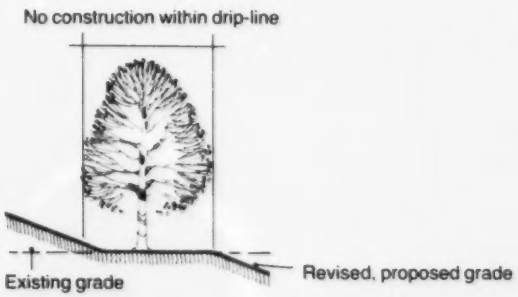


Fig. 70 This tree, situated on a slope, was preserved by using a stone and concrete wall.

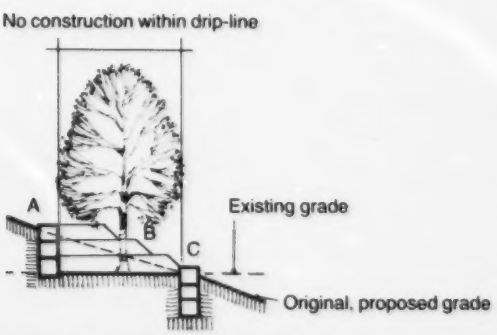
Ideally, no grading should occur within the drip-line of the tree, which is directly beneath the outermost branches. If grading must occur within the drip-line, tree wells or mounds may be needed to ensure that the existing grade around the trunk remains unchanged. Except for trees of substantial value, tree wells with a depth exceeding 750 mm are probably not worth the effort, both because of the high capital costs and the tree's limited chance of survival.



Problem

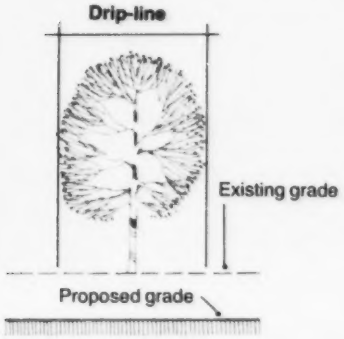


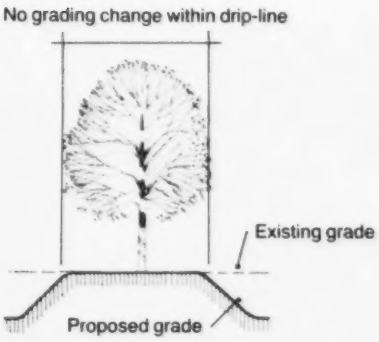
Solution: change proposed grade to avoid disturbance of drip-line area



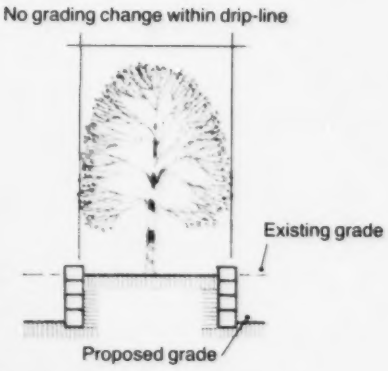
Solution: use retaining walls A and B with optional use of wall C, to maintain existing grade of drip-line area

Fig. 71 If it is not possible to maintain the existing grade within a tree's drip-line area, a partial or complete tree well can be employed.





Problem
Solution A



Solution B

Fig. 72 Methods of preserving a tree when the proposed grade is lower than the existing grade. Considering the long-term maintenance of the steep grass slope in Solution A and the extra capital expense of Solution B, the costs of these two solutions are approximately equal.

A substantial change in grade will require the addition of steps or ramps, especially if retaining walls are incorporated into the layout design. Wherever possible, steps and ramps should be integrated into the design of walls and other site features to facilitate safe pedestrian access. Their construction must conform to all local bylaws and building code requirements. Adding steps after the design has been completed causes unnecessary costs and problems.

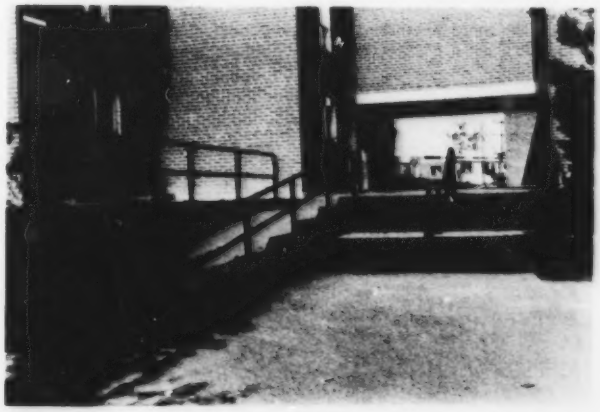


Fig. 73 Steps and ramps always require special consideration because they are major elements of any site layout and grading plans.

Fig. 74 A successful combination of retaining wall, steps and guardrail that is both functional and aesthetically pleasing.

Fig. 75 An insensitive grading design has required the addition of unnecessary steps at the main entrance to this housing development. One solution to this grading problem would be to eliminate between two and four steps at both ends by elevating the walkway, and a culvert could be used to prevent a conflict between the surface water and the walkway.

Ramps provide an alternative method of negotiating a change in grade and are sometimes more acceptable than steps, if they are properly designed. However, both steps and ramps should be used to provide the greatest range of choice for residents. Ramps should have a maximum gradient of 1:12 (8.33 per cent) and should not exceed 9000 mm in length without the relief of level landings. Handrails are recommended for all ramps, although they are not required where the ramp height does not exceed 200 mm. For additional details on design requirements, refer to *Building Standards for the Handicapped 1980*, (Ottawa: National Research Council of Canada, 1980, NRCC 17669).

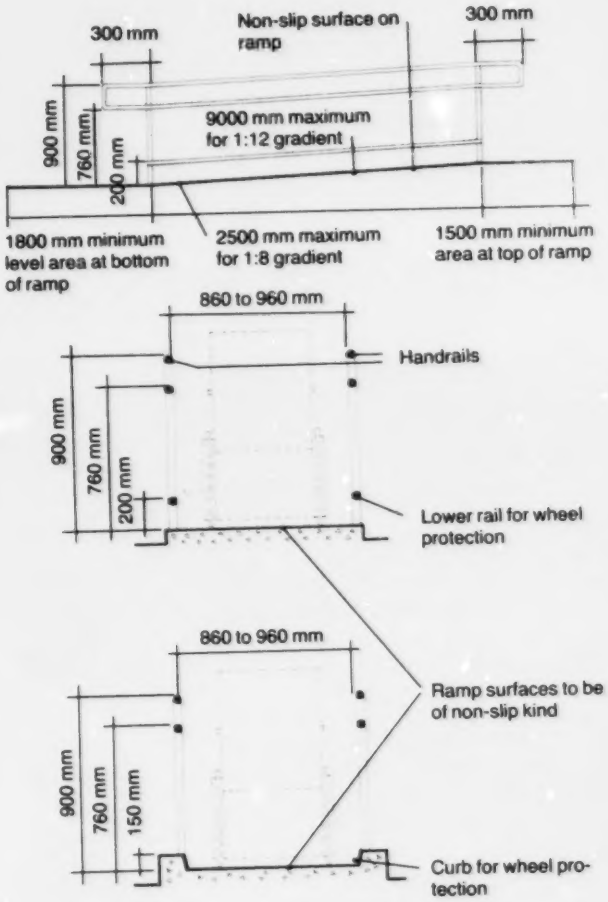


Fig. 76 Ramps for disabled people should not exceed a gradient of 1:12 over a distance of 9000 mm. Ramp widths vary according to the design, but the preferred range is from 860 to 960 mm.

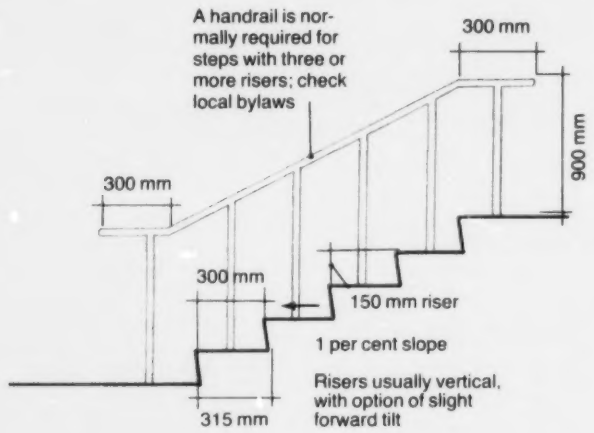

A handrail is normally required for steps with three or more risers; check local bylaws
300 mm
900 mm
300 mm
300 mm
150 mm riser
1 per cent slope
Risers usually vertical, with option of slight forward tilt
315 mm

Fig. 77 Exterior steps generally have a lower riser height and a longer tread length (300 to 375 mm) than interior steps, to accommodate the longer stride and larger footwear people use when outdoors.

Designers of steps and ramps must always bear in mind their safety, cost, degree of use and maintenance. Local climatic conditions should affect the choice of materials, and non-slip surfaces should be used. Broom finished concrete is a good surface texture for steps where snow and ice are common, although every surface requires a certain amount of maintenance to keep it safe and operable. Ensure sufficient night lighting on steps and ramps.

Fig. 78 The build-up of snow and ice on steps and ramps is a safety hazard. Good site design solutions and regular maintenance can reduce the severity of this problem.

3.5 SURFACE DRAINAGE FEATURES

There are many drainage systems and physical features which can be used by the site designer carrying out a grading plan: water retention ponds, berms, swales, ditches, culverts, catch basins, drain inlets, strip drains and curbs.

In certain circumstances it may be desirable to shape the ground to allow surface water to collect in a water storage pond on site. This concept of retaining surface water run-off by reducing the peak water impact on the storm sewer capacity and by providing an attractive site feature, may be economical on large sites. It may also be possible to use a less expensive underground sewer system with fewer or smaller diameter pipes because the peak water impact will be collected by the retention pond instead of the sewer system.

Retention ponds or small lakes can be made to appear as natural features, and they may be used for irrigation and passive recreational use. If run-off retention systems are designed to provide active recreation, then special consideration must be given to health and safety requirements; check local bylaws. When the retention pond concept is being considered for a site, it is advisable to analyse soil conditions, run-off volume, cut and fill volumes, possible erosion and sedimentation problems, as well as resident access and safety. It is also advisable to consult both a hydrologist and engineer when planning a run-off retention system.

Fig. 79 The surface water retention pond within this housing development provides an interesting passive recreational area; moreover, it lessens the initial impact of surface water on the sewer system during a heavy rainstorm.

Earth berms and mounds are used to improve site drainage, to moderate the wind, create visual and noise buffers and enclose private space. Berms are often constructed from excess soil fill that otherwise would have to be removed from the site; they should have gentle slopes that are less than 1:3, appear in visual scale with surrounding landforms, have smoothly rounded edges to make them easier to maintain, and have a sufficient covering of topsoil for plant growth. Planting of shrubs and trees should be confined to the sides and bases of berms, where sufficient water will collect to aid plant survival.

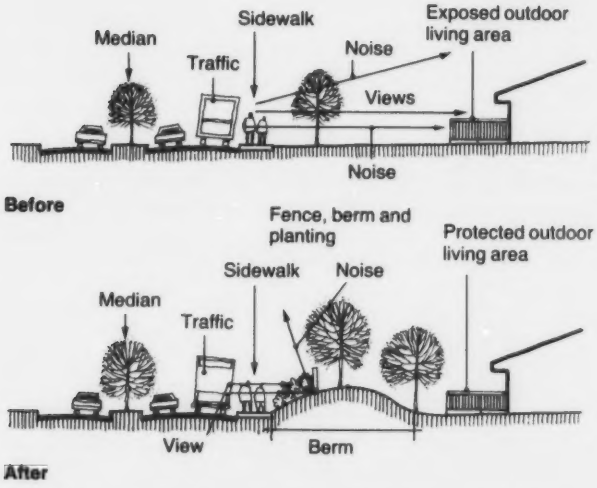


Fig. 80 Creating earth berms may help to control wind and noise and, in conjunction with fencing and planting, can emphasize spatial definition.

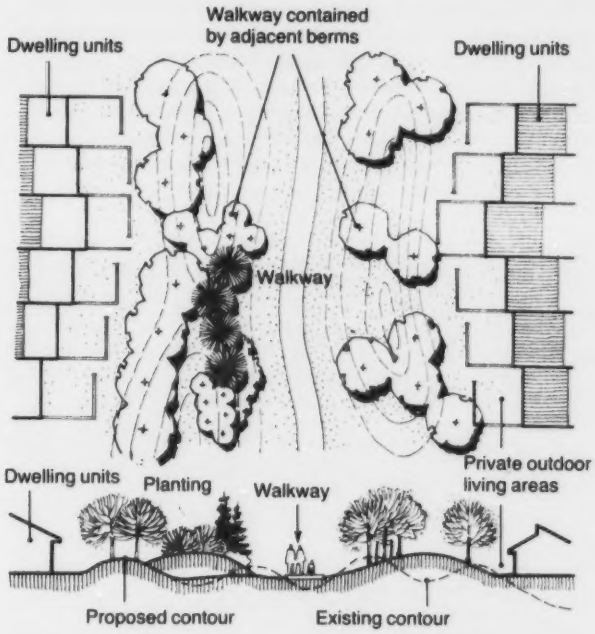
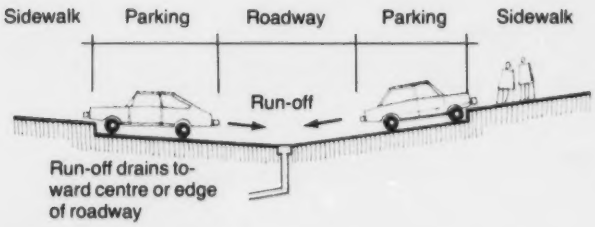


Fig. 81 The addition of berms and mounds can help to control circulation routes, and can also make the site more pleasant.

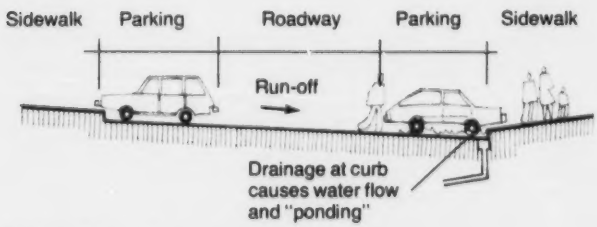
Fig. 82 The berm adjacent to this housing development separates it from the road and gives residents more privacy. Planting on top of the berm is not recommended; planting should always be at the base or sides of a berm so that more water will naturally be available for plant growth.

While appropriate gradients for the various site areas and features are being chosen, a method of removing excess surface water should be decided upon. This is normally a combination of surface and subsurface drainage techniques, such as the use of a swale or curb to direct water to a catch basin or drain inlet. It is important to ensure that the drainage of surface water should not interfere with pedestrian traffic.

Fig. 83 A poor grading design or substandard construction has caused excessive "ponding" on this parking surface.



Solution A – Recommended



Solution B – Not Recommended

Fig. 84 Examples of proper and improper ways of draining a parking area. Solution A causes run-off to be diverted from pedestrians, while B illustrates how water collection can interfere with pedestrian traffic.

Swales are a common drainage technique. They are simply shallow water channels, usually grassed, that are always wider than they are deep. Their function is to direct surface water run-off to other parts of the drainage system, such as catch basins, drain inlets, ditches or retention ponds. One advantage of swales is that some of the surface run-off percolates into the soil, which tends to both reduce run-off volume and add to the ground water supply. Swales should be constructed with gradually sloping sides and rounded edges so that they blend into the site and are easy to upkeep.

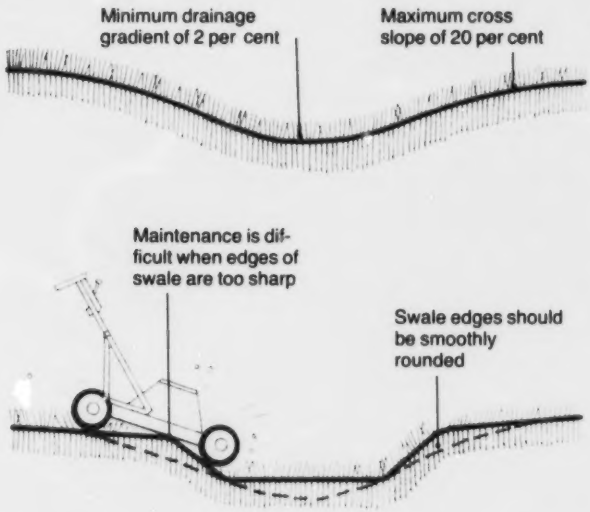

Minimum drainage gradient of 2 per cent
Maximum cross slope of 20 per cent
Maintenance is difficult when edges of swale are too sharp
Swale edges should be smoothly rounded

Fig. 85 Grass swales should be constructed with smoothly rounded edges to make them more attractive and easier to maintain.

When a greater volume and higher velocity of water run-off has to be dealt with, asphalt, concrete or stone can be added to the swale to lessen the possibility of erosion. In various parts of Canada, these are referred to as paved swales, hard-surfaced swales, or flumes.

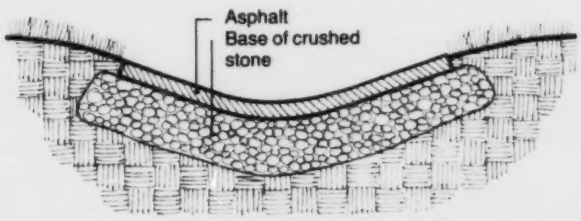


Fig. 86 Cross-section of a paved swale, sometimes called a flume.

Ditches are drainage channels that have a greater depth than width, and are capable of carrying a greater volume and velocity of water than swales. The potential water volume of a ditch is related to its size, gradient and surface material. Erosion may become a problem if the ditch is not suitably constructed to handle the water velocity. Many subdivisions were originally built with open ditches to save on engineering and construction costs, only to be replaced with a storm sewer system in later years. This site development sequence obviously was more expensive than if the storm sewer system had been installed initially. Ditches usually require periodic dredging and regrading to free the channel of silt.

Fig. 87 Drainage ditches are often dangerous and unsightly; generally, they should not be incorporated into a site development because other methods are safer and more efficient.

A culvert is required when a drainage channel intersects a road or walkway. The diameter of the culvert will depend on the anticipated maximum flow, but normally it should not be less than 300 mm; municipal bylaws and other regulations should be observed. Culvert maintenance can be reduced by the addition of a trash screen on the culvert's upstream end.

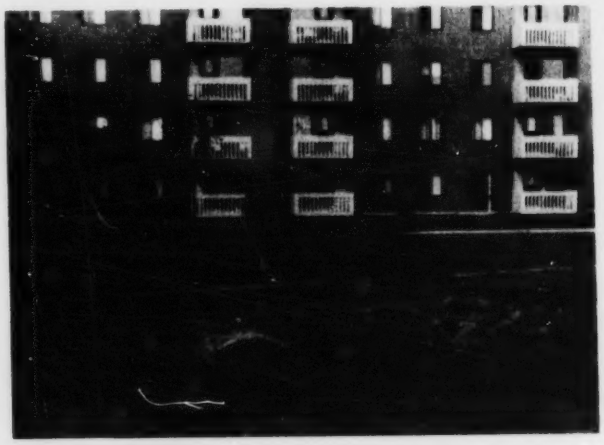
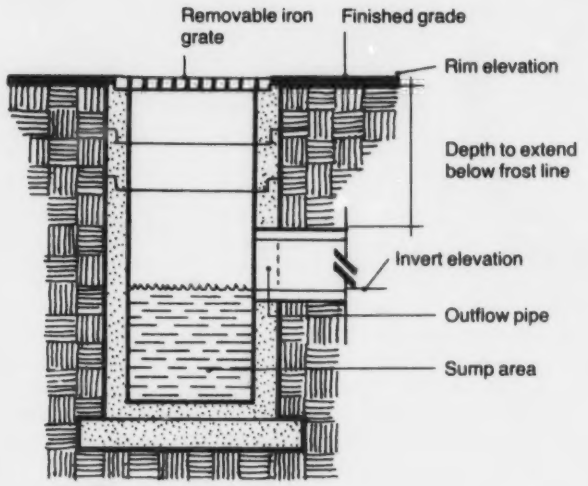


Fig. 88 This culvert enables pedestrians to walk unhindered over the drainage swale.

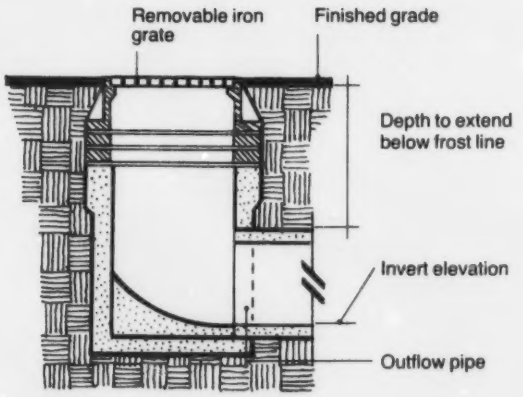
Catch basins and drain inlets are entries to an underground, storm sewer drainage system, and are usually installed before final grading. Both should be fitted carefully into the grading and layout plans to ensure that surface run-off will be efficiently directed towards them.

Fig. 89 A catch basin that is integrated unobtrusively into the layout and grading design so that it functions efficiently.

Catch basins have a sump area below the outflow pipe that enables sediment to be collected, whereas drain inlets lead directly to the outflow pipe. The advantage of the catch basin over the drain inlet is that, although the sump must be cleaned out periodically, a catch basin will cause less sedimentation in the drainage system. This reduces the problem of clogged and damaged drainage pipes, which are much more difficult and expensive to maintain than the sump portion of a catch basin.



Catch Basin

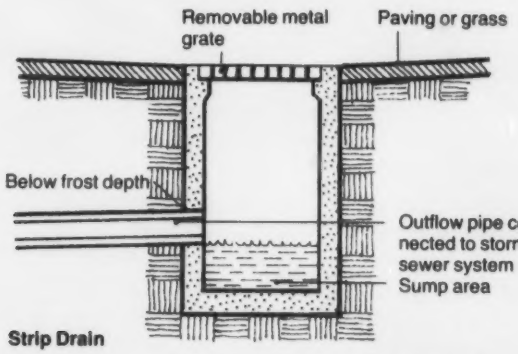


Drain Inlet

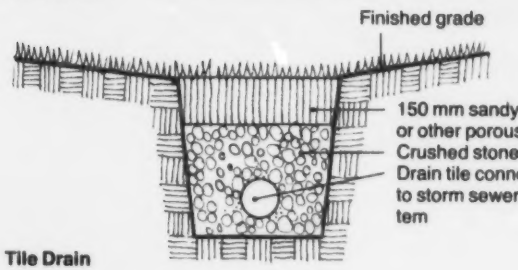
Fig. 90 Cross sections of a typical catch basin and drain inlet.

Fig. 91 An example of poor grading and site drainage that may now require the addition of expensive catch basins or drain inlets.

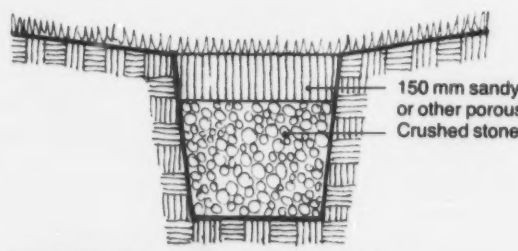
Strip, tile and farm drains are typical ways of collecting run-off from large, flat areas where drainage occurs in a "sheet" fashion. Strip drains are similar to catch basins in that they have a sump area to collect settlement and a removable grate for easy maintenance. Both tile and farm drains consist of small trenches covered with grass. Since the tile drain is connected to an underground drainage system, it provides better drainage than the farm drain; but neither system works when the ground is frozen. Drain tiles may be ceramic, concrete or plastic and should be installed with saddles of tarpaper over the upper half of each joint to prevent soil from entering and clogging them. Farm drains are used only in agricultural situations; it is very likely that they eventually will not drain properly due to becoming clogged with sedimentation.



Strip Drain

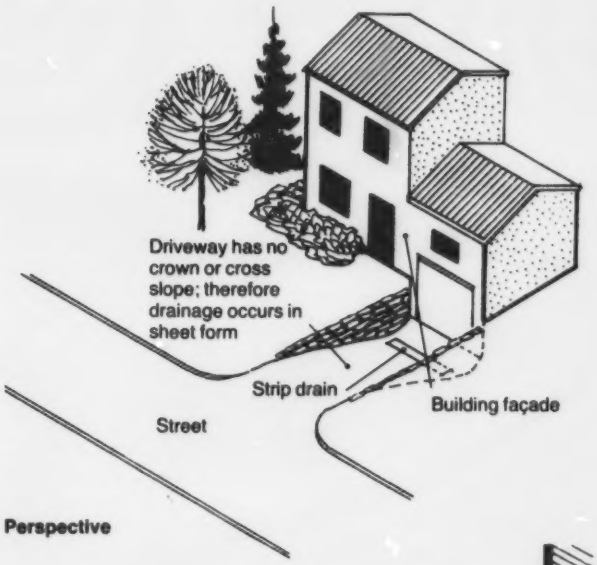


Tile Drain

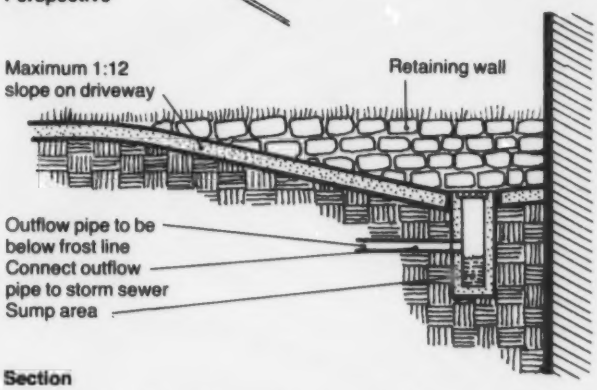


Farm Drain (Sometimes called French drain)

Fig. 92 Examples of strip, tile and farm drains. Sizes and depths will vary,depending on factors like site layout and soils.



Perspective


Maximum 1:12 slope on driveway
Retaining wall
Outflow pipe to be below frost line
Connect outflow pipe to storm sewer
Sump area

Section

Fig. 93 Strip drains allow surface run-off to be collected in a "sheet" fashion. It should be noted that a driveway such as this, which slopes down towards a garage, is not recommended because of safety, flooding and maintenance problems.

In a site layout, a curb essentially separates vehicular and pedestrian areas. Besides, it has the important grading function of directing water to catch basins and drain inlets.

Fig. 94 This cast-in-place concrete curb acts as an edge for both the asphalt vehicular road surface and the interlocking pavers of the pedestrian walkway; it also channels water to a catch basin.

3.6 SUMMARY CHECKLIST

Have the functional and aesthetic aspects of grading been considered? Do these include the removal of surface water from buildings, the creation of useable spaces, the conservation of existing vegetation, and the harmonization of the architectural concept with the on-site development? (Refer to Section 3.1)

Are appropriate gradients maintained for the safe and practical use of site surfaces and amenity areas? (Refer to Section 3.2)

Is all the necessary background information available for the development of the grading plan, such as a site plan to scale and a detailed site survey which illustrates property lines, important elevations, drainage structures, patterns, easements and utility lines and existing site features to be kept? (Refer to Section 3.3)

Can the topsoil be stripped and stockpiled for later use on an unused portion of the site? (Refer to Section 3.3)

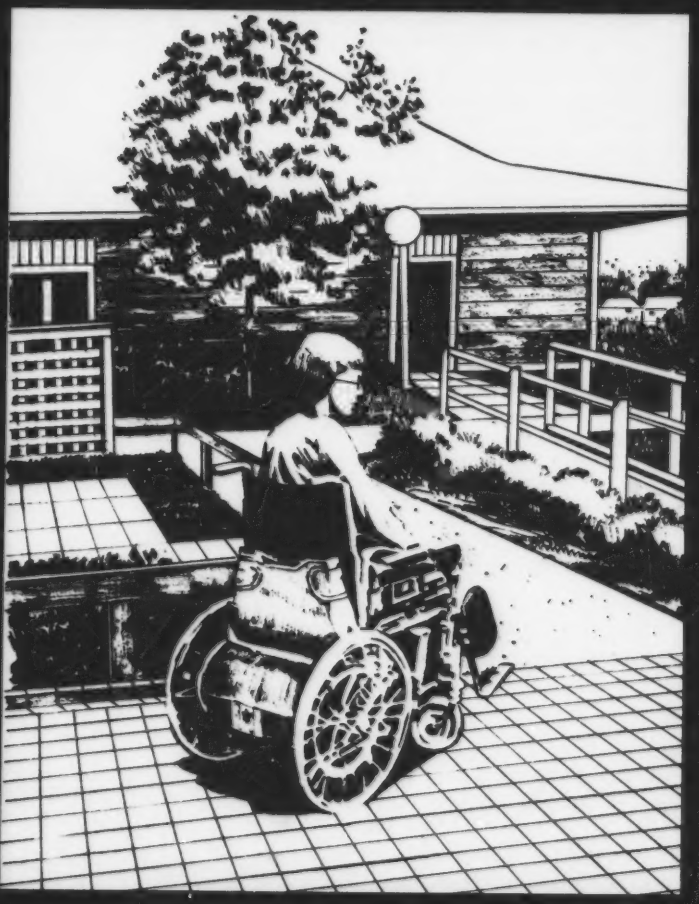
If soil cut and fill quantities do not balance, how much soil will have to be brought to and from the site? (Refer to Section 3.3)

Are such site grading features as retaining walls, steps, ramps and tree wells needed? (Refer to Section 3.4)

Is there a need for surface drainage features, such as water retention ponds, berms, swales, ditches, culverts, catch basins, drain inlets, strip drains and curbs? (Refer to Section 3.5)

CHAPTER 4 — HARD MATERIALS

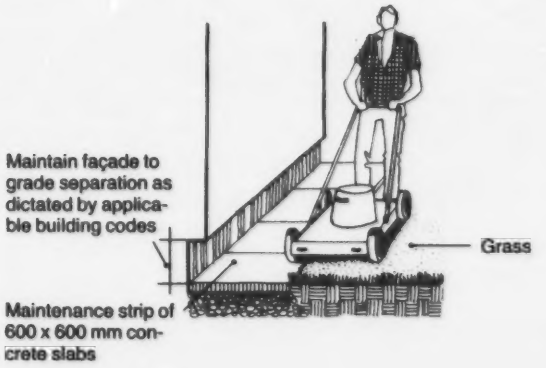
The success of a site development is greatly affected by the materials which are used to turn the combined layout and grading design into a physical reality. Hard landscape materials include paving, walls, fences, screens, site furniture, water features, signage and site lighting. To contribute to a successful site development, these materials must be planned in conjunction with soft landscape elements like lawns and plants. The detailed selection and use of hard landscape materials is influenced by surfaces, heights, widths, lengths, durability, maintenance needs and long-term cost effectiveness.



4.1 MATERIAL APPLICATIONS AND SELECTION

Selecting the right construction materials and putting them to the proper use is very important to the success of a site development. Low maintenance site development and the delineation of property ownership are aspects which depend strongly on the selection of the appropriate materials.

The concept of low maintenance site development is simply the coordination of site layout, grading and materials to minimize the time and costs of maintenance without an unreasonable lessening of the site's purpose and appearance. A specific example of this would be to use hard material maintenance strips between lawns and either buildings or planting beds to lessen hand-trimming and damage from lawn-mowing equipment. For additional details on low maintenance applications, see Section 6.4.


Maintain façade to grade separation as dictated by applicable building codes
Grass
Maintenance strip of 600 x 600 mm concrete slabs

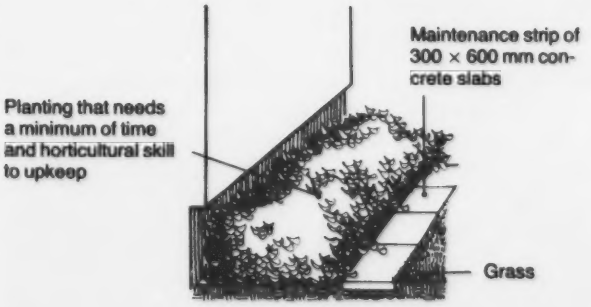

Maintenance strip of 300 × 600 mm concrete slabs
Planting that needs a minimum of time and horticultural skill to upkeep
Grass

Fig. 95 Maintenance strips are normally 300 to 600 mm wide; they should be placed to minimize hand-trimming and to protect plants and building edges from damage by lawn mowers and other maintenance equipment.

Fig. 96 Another low maintenance technique is to treat areas which may be costly to maintain with more durable materials. In this case, cellular concrete pavers are set down for pedestrians taking short cuts across the corner of the walkway intersection.

A visual identification of the limits of property ownership can be achieved by a change of paving materials, a change in level, a physical barrier, or a combination of these. Similarly, a change of paving materials, patterns, colours and textures helps to distinguish areas used for different functions and activities. For example, a textured surface next to a smooth surface may warn a blind person of a danger or hazard. Other variations, such as colour or pattern change, may forewarn people of possible danger from a pool, crosswalk or roadway.

Fig. 97 The change from flagstone paving to exposed aggregate concrete emphasizes the change from public space to communal space. The overhead trellis and wrought-iron gate also reinforce the feeling of territory and ownership.

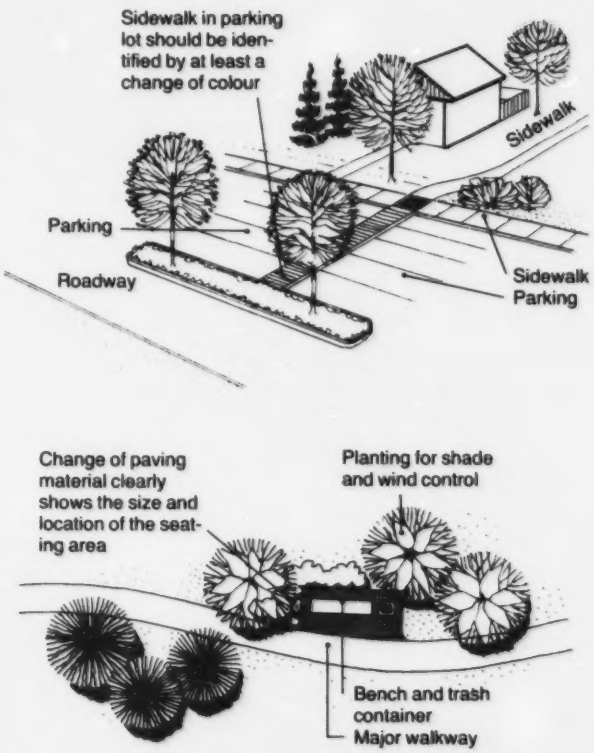

Sidewalk in parking lot should be identified by at least a change of colour
Sidewalk
Parking
Roadway
Sidewalk
Parking
Change of paving material clearly shows the size and location of the seating area
Planting for shade and wind control
Bench and trash container
Major walkway

Fig. 98 Coloured and patterned paving materials can emphasize different site uses.

Materials can also be used to show the direction of pedestrian traffic, either in the alignment of the overall walkway or in details within the walkway. A walkway alignment is determined by the site design; for example, curvilinear layouts tend to indicate a slower and more casual pedestrian movement, while a straight or angular layout denotes a more formal pedestrian route.

Fig. 99 A strong directional character can be seen when following this open space walkway, although the overemphasized jogs are hard to maintain. A curvilinear layout may have been more successful, but the material does not easily lend itself to curvilinear forms.

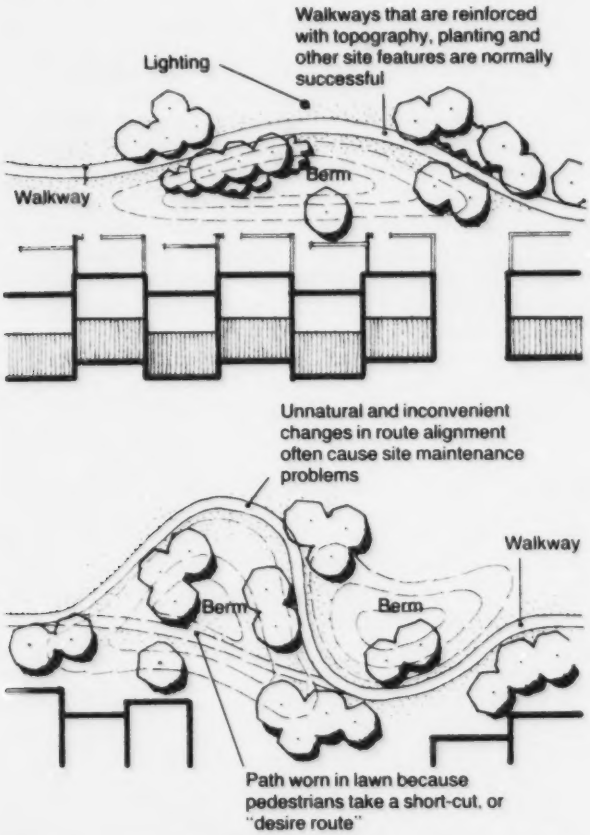

Walkways that are reinforced with topography, planting and other site features are normally successful
Lighting
Walkway
Berm
Unnatural and inconvenient changes in route alignment often cause site maintenance problems
Walkway
Berm
Berm
Path worn in lawn because pedestrians take a short-cut, or "desire route"

Fig. 100 Variations in the layout of pedestrian circulation dictate the flow of traffic, but if the layout attempts to force pedestrians out of their way, it may lead to higher maintenance costs.

Expansion joints in concrete can be used to achieve directional emphasis in a walkway. For example, strong directional influence can be seen if all walkway edges are parallel and all walkway expansion joints are perpendicular to the desired traffic flow. Similarly, a change in texture from smoothly finished concrete to exposed aggregate will encourage pedestrians to follow the material of least resistance.

Fig. 101 Concrete sidewalks generally require little maintenance and can be designed as part of an attractive site landscape, as is shown in this example. The expansion joints were installed in an angular pattern to complement the walkway's form.

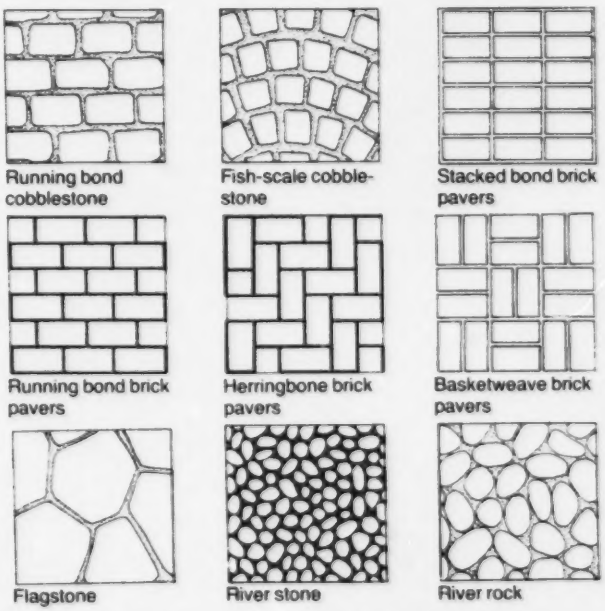


Fig. 102 Typical paving patterns and other hard-surface treatments. Normal building brick will not survive if it is used as an outdoor pavement; the brick pavers shown here are hardened for outdoor use.

Once hard landscape areas have been identified on the site layout plan, it is very important to select the right materials to satisfy the site design objectives. The following factors should be borne in mind:

- local availability of the materials
- their adaptability to the specific intent of the layout design
- initial purchase and construction costs
- long-term cost effectiveness of capital expense
- simple repair and maintenance procedures.

In addition to these, the following four criteria can be employed when choosing paving materials.

The first requirement is durability. Will the material withstand normal use and pressures like winter freezing? For example, normal building brick will not survive more than a few years if it is used as outdoor paving.

Safety, noise and light reflectivity are important determinants of public safety. Do climatic conditions suggest selection of a non-slip surface? Will the material tend to reflect or absorb unwanted noise and light, depending on its location?

Another criterion is the material's subsoil and drainage characteristics. Do subsoil conditions suggest the use of an impervious surface with full drainage, or should the paving material allow precipitation to penetrate to the soil? What is the allowable range of gradients for the material to be used safely and easily?

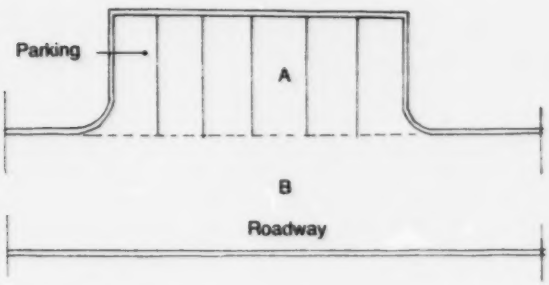
The fourth selection criteria are the procedures and cost of maintenance. For example, are the maintenance requirements too demanding to allow for continued use of the same material? Are procedures such as cleaning and repairs difficult and costly? Have regional peculiarities been taken into account?

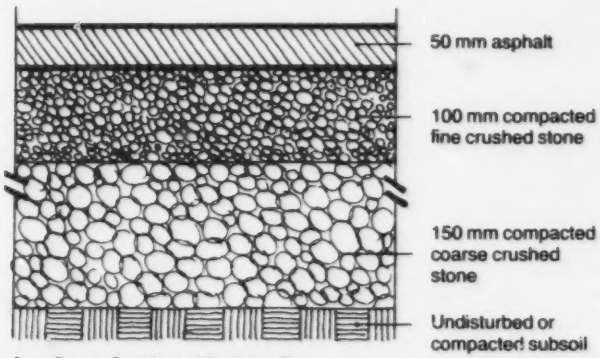
4.2 PAVING MATERIALS

This section analyzes individual paving materials. At the end, a chart summarizes and compares them all.

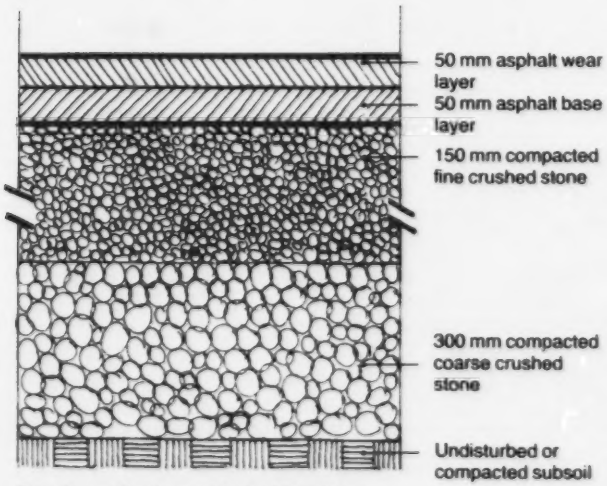
One widely used paving material is asphalt. The main function of a paved surface is to provide a hard, durable, non-slip surface which will withstand pedestrian and vehicular traffic. Since asphalt has these basic qualities and is one of the least expensive hard-surface materials, it is commonly used for pavements in site development, such as paths, playgrounds and parking lots. Asphalt requires a moderate degree of maintenance. When it cracks, it is usually the result of poor subgrade preparation or severe frost. Well-constructed asphalt roads will often last for ten years before they need to be resurfaced. In playgrounds, asphalt is satisfactory for wheeled toys and ball games but its non-flexing surface makes it dangerous for preschool-age play, since children frequently fall on it and hurt themselves. Asphalt curbs should not be used on roads and parking areas from which snow will be removed, since they are easily damaged and require a great deal of maintenance. The paving, crushed stone base and subsoil layers must always be individually and thoroughly compacted.

Fig. 103 Heavy trucks can damage asphalt surfaces not designed for their weight. Such wear and tear can be avoided if reinforced concrete pads are placed where front pick-up garbage trucks park while they are lifting and emptying garbage bins.




50 mm asphalt
100 mm compacted fine crushed stone
150 mm compacted coarse crushed stone
Undisturbed or compacted subsoil

A — Cross Section of Parking Bay


50 mm asphalt wear layer
50 mm asphalt base layer
150 mm compacted fine crushed stone
300 mm compacted coarse crushed stone
Undisturbed or compacted subsoil

B — Cross Section of Project Roadway

Fig. 104 In an asphalt parking area which receives less vehicle weight and traffic volume than a roadway, the construction requirements can be decreased. Certain subsoil conditions and other factors will necessitate different construction details than those illustrated, such as increasing the depth of compacted crushed stone.

Concrete is a frequently used paving material that can be formed into practically any shape before hardening. The design variations are almost unlimited. Initially, concrete is an expensive paving material compared to asphalt, although the cost depends on its thickness, quality and finish, and the distance it has to be moved to the construction site. However, it is very durable and requires little long-term maintenance.

Fig. 105 Concrete can easily be cast into various shapes by the application of wood forms.

Various concrete surface finishes are available. Broom finishes are achieved by drawing a stiff broom across a surface which has been levelled with a trowel before the concrete has become hard. This produces a textured surface that helps traction underfoot. Other non-slip surface treatments include exposed aggregate finishes, sand-blasting, and use of imprinting tools to give the concrete surface a textured appearance, for safety and appeal.

Fig. 106 An exposed aggregate concrete sidewalk with wood expansion joints. This type of sidewalk should be built only in a mild climate because repeated freezing and thawing will crush the wood and dislodge some of the exposed aggregate. Besides, snow and ice become harder to remove as the surface texture of any paving material coarsens.

Expansion joints are a necessary element of a concrete surface, and should be located about 3 m apart to be most effective. They visually reinforce the design by indicating circulation direction and enhance the surface treatment by creating interesting patterns.

Precast concrete paving blocks are similar in appearance to cast-in-place concrete, and are available in various colours, shapes and surface materials. They can be easily laid into a grid paving pattern, and can be set either with open joints or closely butted together (see Figure 107).

For further information on concrete surfaces, finishes and construction techniques, refer to: *Concrete Materials and Methods of Concrete Construction*, Canadian Standards Association, 1977, Standard CAN3-A23.1-M77.

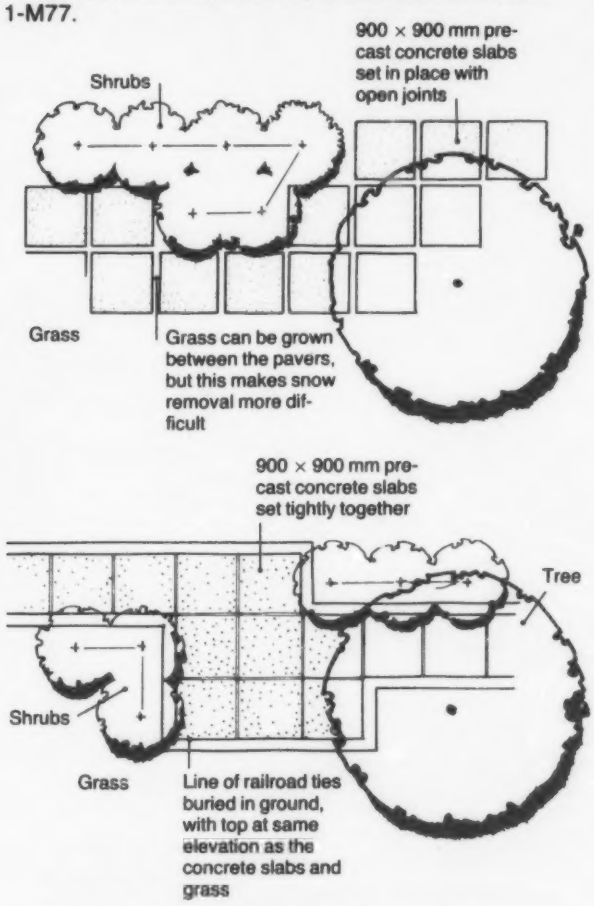

900 × 900 mm precast concrete slabs set in place with open joints
Shrubs
Grass
Grass can be grown between the pavers, but this makes snow removal more difficult
900 × 900 mm precast concrete slabs set tightly together
Tree
Shrubs
Grass
Line of railroad ties buried in ground, with top at same elevation as the concrete slabs and grass

Fig. 107 Precast concrete paving blocks are easily laid into a grid paving pattern, and can be set with open or closed joints.

Fig. 108 Precast concrete paving slabs make an effective pad for this bench and the nearby area used by pedestrians.

Interlocking concrete pavers are obtainable in a variety of shapes and colours. Their shape often determines the pattern in which they must be laid; minimizing the movement of the blocks makes them stronger and more rigid. The success of this paving material depends upon its sub-base preparation, the shape of the paving unit and the pattern in which it is laid. Poor design and careless installation often lead to expensive repairs. Interlocking pavers cost approximately the same to install as cast-in-place concrete, although maintenance may be higher. However, a definite advantage is that they can be lifted and reused.

Fig. 109 Interlocking pavers set on sand in a herringbone pattern and surrounded by a concrete edge.

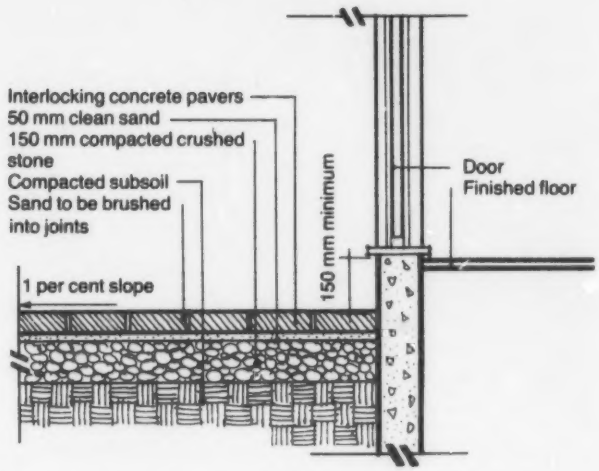


Fig. 110 A typical section view through interlocking concrete paving used as a patio surface.

Cellular concrete pavers blend the qualities of hard-surface paving with grass and thereby create a durable surface that is excellent for overflow parking, fire lanes, and other limited vehicular traffic. These pavers are also used to stabilize slopes and so limit erosion, and as a walking surface for occasional pedestrian traffic. Installation of cellular concrete pavers is similar to interlocking pavers, except that the topsoil and grass must be placed in the open cellular structure. As a result, this surface requires slightly more maintenance than interlocking pavers because the grass must be mowed and watered.

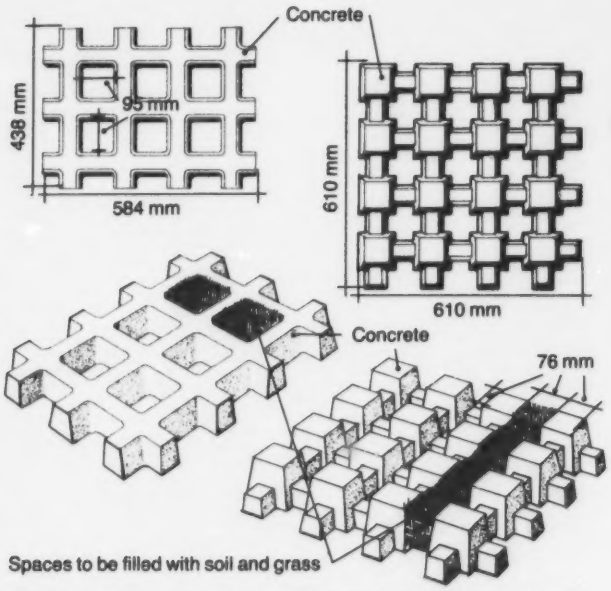


Fig. 111 Two examples of cellular concrete pavers that have been cast to allow grass to be grown in the open spaces.

Fig. 112 Cellular concrete pavers here provide a secondary walkway next to the concrete sidewalk, thus avoiding having to fill the entire space with a continuous paved surface.

Flagstone, tile and brick paving are very expensive because of their limited availability and the great deal of labour required to install them. However,the finished product is extremely attractive and durable if it is well constructed. Preferred types of stone are granite, quartzite and slate.

Brick pavers are not normal building brick, but a special high-density material that is specifically manufactured for outdoor paving. They are installed in the same way as interlocking pavers but, for a stronger and more permanent surface, it may be desirable to install them as pavers on a concrete slab and surround them with mortar.

Fig. 113 Part of a central plaza in a housing project, where brick pavers and flagstone have been used as paving materials.

Gravel, stonedust and shale are additional paving materials, although they are not used often, mainly because they are less durable than the other materials. Gravel is an easily worked and relatively inexpensive material, but is not really suitable as a surface for pedestrian movement because of its instability. Shale and stonedust can be compacted to form a relatively hard surface if a lot of fine particles are mixed in and the surface receives steady foot traffic; however, even if these conditions are met, shale and stonedust are easily damaged during snow removal. All rock, gravel, shale and stonedust surfaces should be contained with some type of edging to prevent them spreading onto adjacent lawns or shrub beds; lawnmowers sometimes "shoot" rocks, causing damage to windows and even people. Since gravel and other stone surfaces have so many limitations, their use should be restricted.

Fig. 114 Even when crushed stone or gravel (rounded edges) is contained within wood edging, it is often unsatisfactory as a pedestrian walkway because it is costly to maintain and is often unsafe. People with wheelchairs and walking canes find it almost impossible to move on them.

Fig. 115 If large loose river stone is inadequately contained, it may lead to vandalism and maintenance difficulties.

Wood decking is an attractive surface material for private areas and roof decks. It is clean, easily constructed (although costly) and requires only moderate upkeep if it is treated with wood preservative; however, it can be quite slippery when wet or icy. Cleaning snow from wood decking is difficult because of the spacing between the boards and the uneven deck surface. It can be installed at or above grade, and is an excellent choice when level changes are required to preserve existing slopes. Terracing with wood decks is one method of exploiting a steeply sloping site.

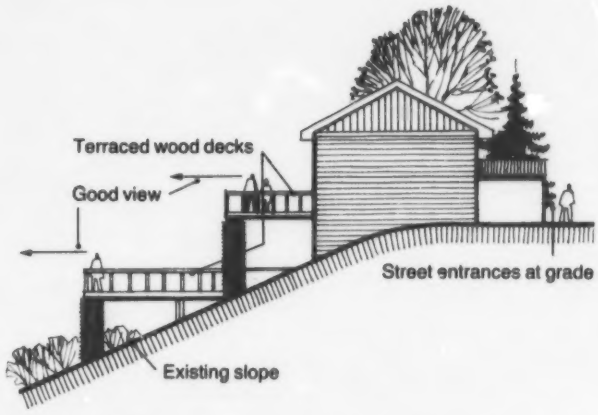


Fig. 116 Terracing with wood decking on a steep slope creates more space and eliminates the need for expensive retaining walls.

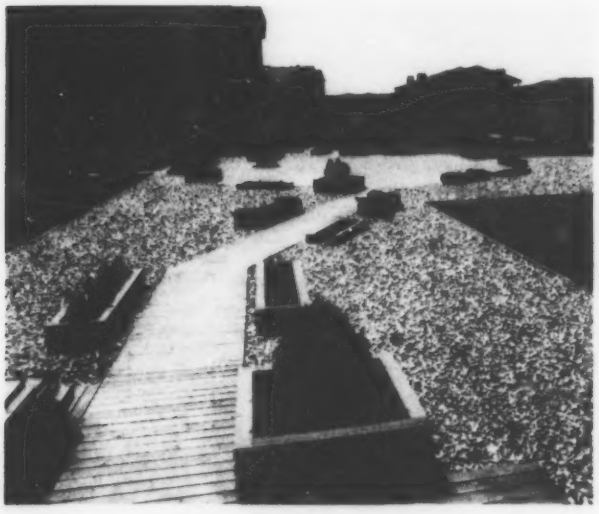


Fig. 117 Wood decking and gravel have been put down on this parking garage roof as a substitute for a lawn; resulting in a barren appearance.

Surfacing Material	Appearance	Durability	Safety*	Application and Cost**	Repairs and Maintenance	Advantages	Disadvantages
Concrete	Good - fair (depends on finish)	Excellent	Good	(sidewalk; 100 mm, crushed stone base) $25-$35/m²	Low	Very strong, easily formed, various textures, non-slip	Limited colour choce, subject to cracking, requires expansion joints
Asphalt	Limited - poor	Good	Good	(parking area; 50 mm crushed stone base) $15-$20/m²	Moderate	Moderate price, easily formed, resilient, good snow removal qualities	Requires resurfacing, subject to load restrictions, limited colour choice
Flagstone	Excellent	Excellent	Good	(patio or walkway on sand base) $80-$110/m²	Low	Attractive, permanent, very durable	Very expensive, difficult to install, may not be readily available
Interlocking Pavers	Good	Excellent	Good	(patio or walkway on sand base) $35-$45/m²	Low	Long-wearing, easily installed and maintained, attractive and reclaimable	Requires edging, and good sub-base preparation for long life
Brick Pavers	Excellent	Good	Fair	(walkway on concrete slab) $70-$100/m²	Low	Long-wearing, many design variations, earth colours	Difficult to remove snow from; subject to freeze/thaw damage
Cellular Concrete Pavers	Excellent	Good	Fair	(firelane; sand and crushed stone base) $40-$50/m²	Moderate (mowing)	Requires less maintenance than grass, slope stabilization, fire lanes, attractive	Not recommended for all types of foot traffic, expensive, grass must be watered and mowed
Gravel, Stonedust, Shale	Fair	Fair	Fair	(maintenance strip; crushed stone, 100 mm deep) $5-$10/m²	High (for itself and adjacent areas)	Inexpensive, average maintenance if used in correct locations	Requires compaction and edging, high maintenance if disturbed, snow-clearing problems
Wood Decking	Good	Fair	Fair	(on-grade, cedar decking on pressure-treated spruce) $70-$100/m²	Moderate	Many design variations, attractive	Requires moderate repair and maintenance, limited life span, must be treated for resistance to rotting, difficult to clear snow from

*Safety is rated on the ability to accommodate all types of foot traffic with a minimum of slipping, tripping and falling.
**These costs are based on typical supply and installation, including sub-base, for 1981 in Alberta; costs will obviously vary, depending on the intricacy of design, quality of material, installation procedures and local availability of materials.

Figure 118 Summary and comparison of paving materials.

4.3 WALLS AND FENCES

Walls, fences and screens are built to provide enclosure, visual screening, climate control, and security. Sometimes they may be used to deaden noise from nearby streets or public places. For additional information on noise control, refer to *Road and Rail Noise: Effects on Housing*, (Ottawa: Canada Mortgage and Housing Corporation, 1981, NHA 5156). Section 3.4 deals with retaining walls.

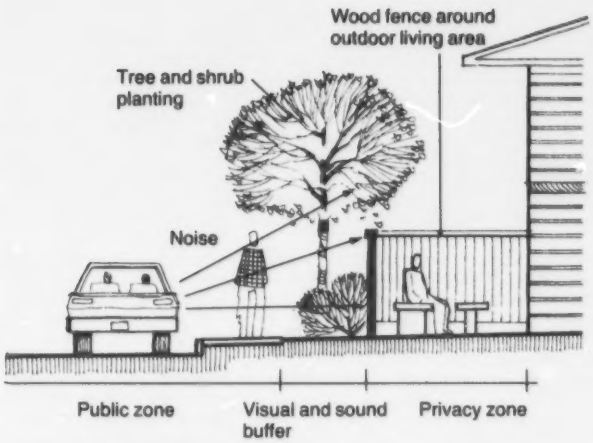


Fig. 119 Fences and walls preserve privacy, reduce noise and increase security.

Walls may be incorporated into a site development as part of an elevation change, a screen, a major decorative feature, or as a support for a raised planting bed. These walls are usually built of cast-in-place concrete, decorative concrete block, brick, stone, or wood.

Concrete walls are seldom found on site except as retaining walls, because of their expense and unattractiveness. To increase their colour and texture, they are sometimes faced with a brick veneer or sandblasted. Various forming techniques may also be applied to add variety and interest to the exposed face of cast-in-place walls.

Fig. 120 The stucco finish on this concrete wall enhances its texture and harmonizes with the building's façade.

Fig. 121 This cast-in-place concrete wall was built to enclose a parking area. It could have been made more attractive if it had been textured, using exposed aggregate or by sandblasting.

Decorative concrete block walls are lighter and less expensive to construct than cast-in-place concrete, but they too must be specially designed if they are to become attractive landscape features. One way of improving their appearance is to glaze them with colour; another is the split-face design, where blocks are offset by gaps to add variety and texture. Concrete block walls are used primarily on industrial and commercial sites. Both cast-in-place and decorative concrete block walls require concrete footings, usually reinforced, which must be designed with local soil and frost conditions in mind.

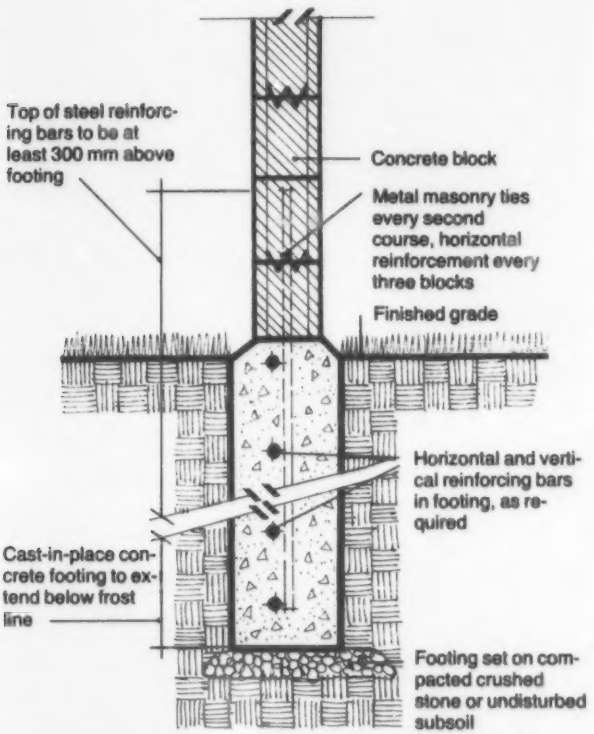

Top of steel reinforcing bars to be at least 300 mm above footing
Concrete block
Metal masonry ties every second course, horizontal reinforcement every three blocks
Finished grade
Horizontal and vertical reinforcing bars in footing, as required
Cast-in-place concrete footing to extend below frost line
Footing set on compacted crushed stone or undisturbed subsoil

Fig. 122 Cross section of a typical concrete block wall.

Brick walls are very effective when they echo the building façade materials and so create a distinctive visual character for the site development. Brick and concrete walls require expensive reinforced concrete footings, which should be accurately aligned and levelled. The most common way of using brick as a wall material is to place it as a veneer over concrete or concrete block walls. Another is to build the bricks into square pillars set between wooden fence panels in order to create an attractive fence/wall design.

Fig. 123 This brick wall separates a communal space from a public roadway.

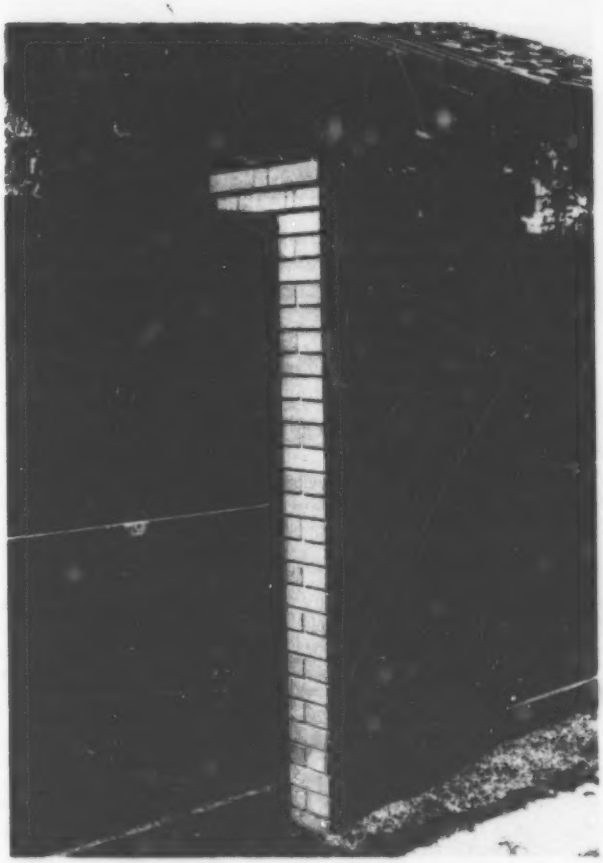


Fig. 124 Brick pillars may be placed between wooden fence panels to produce a solid and attractive, though somewhat expensive, combination fence and wall.

Fencing can be an important means of creating an attractive housing development, as well as a useful way of defining individual properties. Wood and metal are the most common fencing materials. Wrought-iron fencing is used occasionally but it is prohibitively expensive. Foreground planting next to long rows of fencing reduces its otherwise monotonous appearance while adding to the visual character of the housing development. A variation in fence layout may also serve the same purpose.

Fig. 125 Foreground planting and this attractive fence design changed what otherwise may have been a monotonous visual effect produced by the long line of frontage fencing.

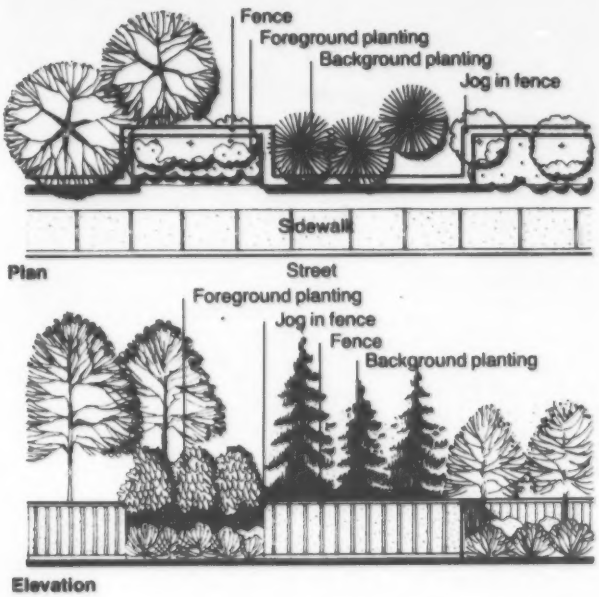


Fig. 126 An example of foreground and background planting used in conjunction with a more varied fence layout.

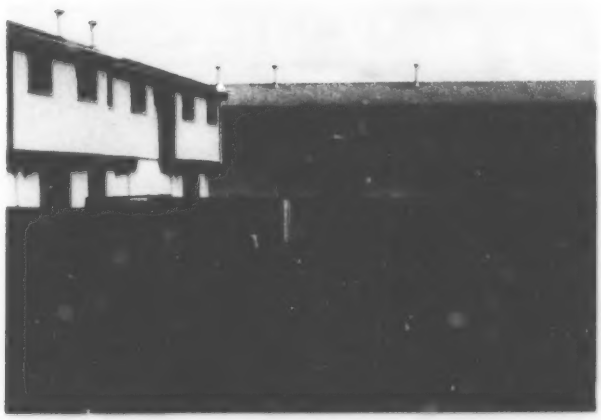


Fig. 127 This communal space looks barren and uninviting, because of the long dull rows of fencing and the absence of other landscape features, such as landforms and plant materials.

Wood is the most commonly used material for fences because of the wide range of possible designs; it is also readily available and straightforward to build with. The ease of maintenance, as well as general appearance, should be foremost in the designer's mind when considering a wood frame. It should be constructed from lumber that has been pressure-treated with preservative, or wood such as cedar, which has particularly good weathering qualities. Staining, painting or protecting the wood must be done periodically to maintain its appearance and protect the fence from excessive weathering.

Fences which separate private and communal areas normally have a one metre wide gate. Wooden gates must be carefully built to ensure that they are safe and durable the year round.

Fence posts should be set plumb, below the frost line and on compacted subgrade, with either crushed stone backfill or concrete around the post. At least two-fifths of the post should be set below grade to make it stable. Fence panels and slats should be a minimum of 150 mm above finished grade so that the grass can be cut.

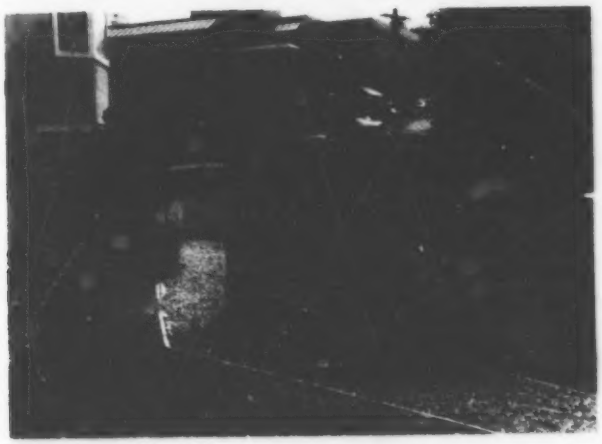


Fig. 128 Fencing must be planned in conjunction with walkways to avoid problems like this.

Fig. 129 Foreground planting and a well-designed fence create this entrance court and clearly define the ownership boundary.

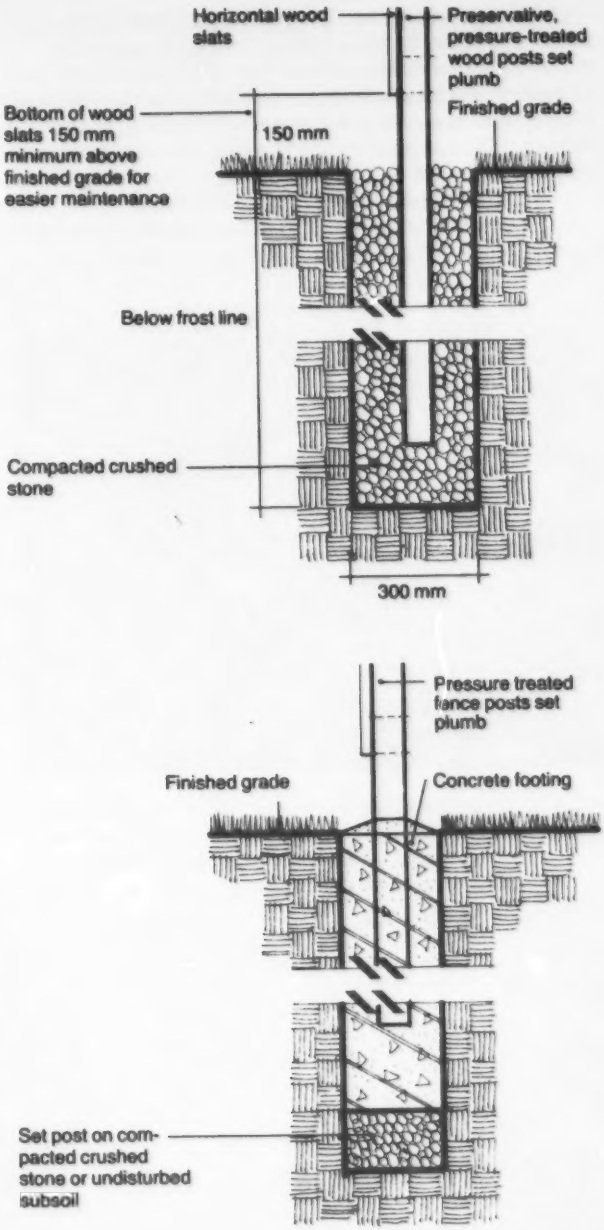

Horizontal wood slats
Preservative, pressure-treated wood posts set plumb
Finished grade
Bottom of wood slats 150 mm minimum above finished grade for easier maintenance
150 mm
Below frost line
Compacted crushed stone
300 mm
Pressure treated fence posts set plumb
Finished grade
Concrete footing
Set post on compacted crushed stone or undisturbed subsoil

Fig. 130 Typical fence post installation in compacted crushed stone or concrete.

Chain-link fencing is often used around tennis courts, swimming pools and busy playgrounds because it is durable and not difficult to maintain. It is very secure, but its semi-transparent appearance makes it most useful when visual screening, noise and wind control are not required. Chain-link fencing is usually not used next to housing since it is expensive and does not visually screen. A common solution is to build it beside evergreens or other plants to make a long-term, secure barrier that is more attractive than just the fence.

Fig. 131 Chain-link fencing is commonly used around tennis courts, swimming pools and other outdoor recreation areas because it allows air to circulate, is very durable and increases security.

Garbage storage areas may be enclosed by fences, walls, planting, landforms, or any combination of these to make them less unsightly. When garbage storage has been inadequately screened, it becomes an eyesore.

The most common type of garbage enclosure is a wooden fence completely surrounding the garbage bin. Wide doors are usually provided on the front to allow easy access to the garbage truck. The design should allow air to circulate so that odours do not build up within the enclosure, but animals must be stopped from poking in the garbage. Both truck and pedestrian access doors should be designed so that they work easily in the winter when snow accumulates. Elevation changes and planting may also be used to screen garbage storage areas.

Fig. 132 This concrete wall encloses a garbage container. It might have blended better with the general site development if it had been made with the same materials as the buildings and planters, and had been more conveniently located.

Fig. 133 This simple but effective garbage bin enclosure is easily accessible and not unsigh[illegible].

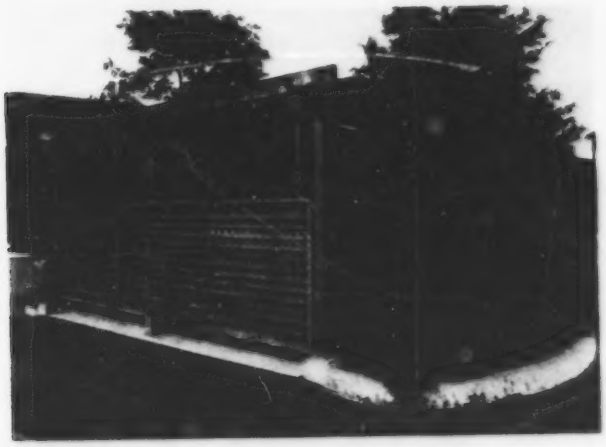


Fig. 134 A garbage storage area that is carefully located within the site development, carefully designed and screened with planting.

4.4 SITE FURNITURE AND OTHER FEATURES

Site furniture and other features include benches, waste containers, planters, bollards, water features and play structures. These should be placed so that they do not interfere with maintenance operations, snow removal and pedestrian traffic. Site furniture can vary significantly in style, size and cost. Generally, site furniture that is custom-designed and built will cost more than items of similar quality available from manufacturers' catalogues or competitive retail suppliers. In many housing developments, communal space is provided which contains benches, planters or play structures. Signage and site lighting should be regarded as basic requirements in all site developments (refer to Sections 4.5 and 4.6 for more details).

Benches offer a reasonably inexpensive method of providing passive recreation for adults. They can be designed and located to harmonize with other site furniture, such as planters, information kiosks and lighting, as well as landforms and planting. Taking a little extra care with the design can greatly improve a site's visual appearance at little or no additional cost. Benches should have backrests because all people benefit from back support when they are sitting; also, many elderly and partially disabled people need to be able to hold onto the backrest when they sit down or stand up from the bench.

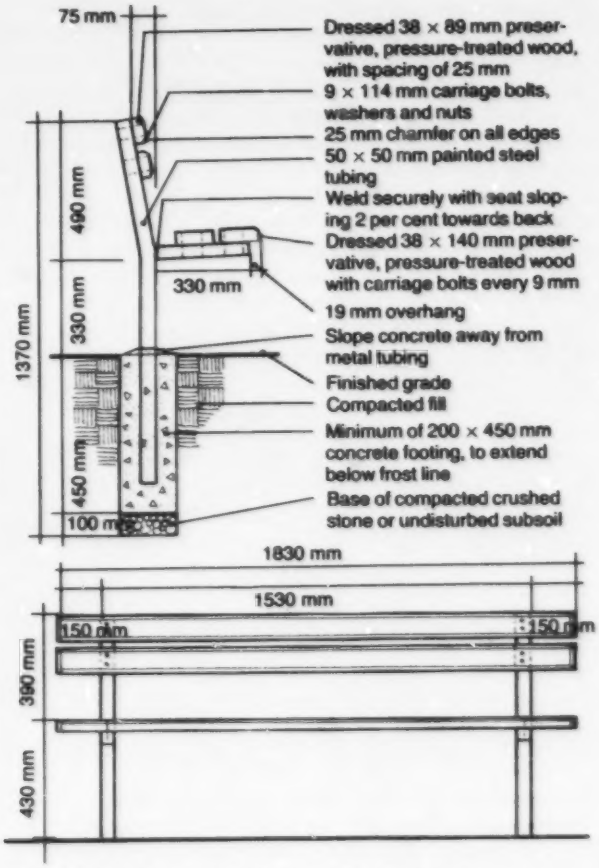

75 mm
Dressed 38 × 89 mm preservative, pressure-treated wood, with spacing of 25 mm
9 × 114 mm carriage bolts, washers and nuts
25 mm chamfer on all edges
50 × 50 mm painted steel tubing
Weld securely with seat sloping 2 per cent towards back
Dressed 38 × 140 mm preservative, pressure-treated wood with carriage bolts every 9 mm
19 mm overhang
Slope concrete away from metal tubing
Finished grade
Compacted fill
Minimum of 200 × 450 mm concrete footing, to extend below frost line
Base of compacted crushed stone or undisturbed subsoil
490 mm
330 mm
330 mm
1370 mm
450 mm
100 mm
1830 mm
1530 mm
150 mm
150 mm
390 mm
430 mm

Fig. 135 A typical wooden bench with a backrest.

Some guidelines for designing benches and waste receptacles are:

- benches should be comfortable
- benches should be designed to face an interesting view whenever possible
- seating areas should be protected from strong wind and sun
- benches should be designed so that they can be placed in groups to encourage social interaction, or separately for privacy
- waste receptacles should be set close to benches
- one waste receptacle should be placed near every two benches, and at the intersections of major walkways
- benches and waste receptacles must be durable and resistant to weathering and vandalism
- some maintenance will be required for all types of site furniture
- special consideration should be made for disabled people.

Fig. 136 The possibility of vandalism should be borne in mind when designing or selecting site furniture. As can be seen in this example, even solidly constructed concrete furniture can be damaged.

Planters vary in size from small pots that are easily moved, to large cumbersome plant containers made of either precast or cast-in-place concrete. Concrete planters may be faced with brick veneer, or treated with sandblasting or forming techniques to create surface textures. Rough-sawn timber or railroad ties are often used because they are both easy to work with and are readily available. However, if there is any possibility of people sitting down on the edges of the planters or even touching them, it should be realized that railroad ties are often treated with creosote wood preservative. Their oil base stains clothes and hands.

Besides their obvious function of holding soil for plants to grow in, planters may serve a number of other purposes; they

- define space
- help create or hide level changes
- provide a barrier between incompatible activities
- provide for vegetation on roof decks and other areas unsuitable for conventional at-grade planting.

Designers should keep in mind the stability of the walls of larger planters in withstanding internal pressure because of soil and water. Walls should be designed to overcome these pressures and prevent the wall from bulging outwards or breaking. Pressure from water weight and freezing can be reduced by placing a vertical layer of crushed stone behind the wall; and weep- holes can be installed so that water will escape rather than build up, especially when the wall is more than 900 mm high. Another way of removing excess water from a planter is to put water drains and a layer of crushed stone at the bottom of it. To prevent the soil being washed down into the gravel and eventually into the drains, a soil separator is placed between the soil and the crushed stone underneath.

Fig. 137 A good example of circular brick planters that complement the curvilinear design of the brick wall in the background. Planters as high at this must have weepholes at their base for adequate drainage.

Thermal insulation is needed both under and around root zones to protect potted plants. In winter, roots must be protected from the frequent thawing and refreezing, which can be caused either by sunlight striking the sides of a planter box or from the heat from below, as is the case with a roof deck planter. To solve this problem, it is customary to place rigid insulation on the sides of all planters exposed to the sun and on the bottom of all planters situated on top of heated buildings or garages. The freezing of the soil in winter causes some expansion, which tends to crack or push out the walls of a rigid container which has no compressible material on its inside surfaces. For further information on roof deck planters, benches and waste containers, refer to *Roof Decks, Design Guidelines*, (Ottawa: Canada Mortgage and Housing Corporation, 1973, NHA 5220).

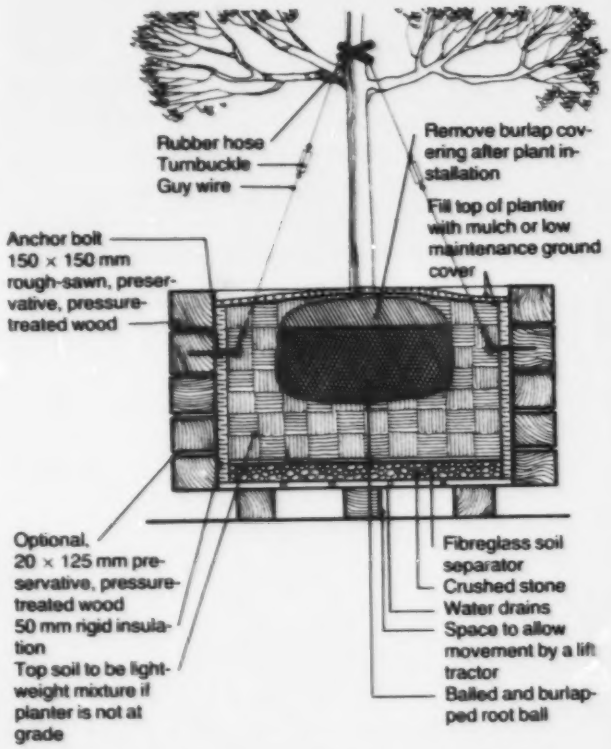

Rubber hose
Turnbuckle
Guy wire
Remove burlap covering after plant installation
Fill top of planter with mulch or low maintenance ground cover
Anchor bolt
150 × 150 mm rough-sawn, preservative, pressure-treated wood
Optional, 20 × 125 mm preservative, pressure-treated wood
50 mm rigid insulation
Top soil to be lightweight mixture if planter is not at grade
Fibreglass soil separator
Crushed stone
Water drains
Space to allow movement by a lift tractor
Balled and burlapped root ball

Fig. 138 If this typical wood planter is placed over a heated building or garage, 75 mm of rigid insulation should be included between the soil separator and the gravel.

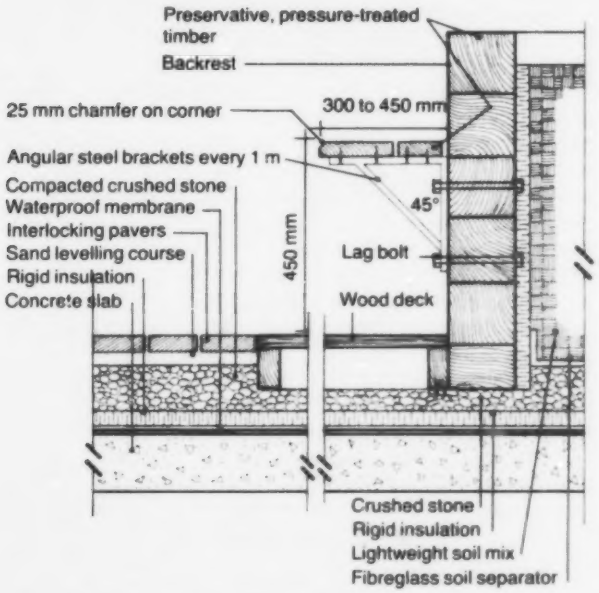


Fig. 139 Typical construction detail of a combination wood bench and wood planter on a roof deck.

Bollards are free-standing, vertical barriers which prevent vehicular access into walkways and other pedestrian areas. They are typically built of concrete, wood, steel, brick or stone and are often located at the entrance to fire lanes to prevent non-emergency traffic from entering. The most common types of bollards are the "removable" or "fold-down" kind, which can be quickly removed when emergency access is required. Bollards are also used with electrical outlets for vehicles and for lighting paths, building entrances, and the intersections of walkways and roads.

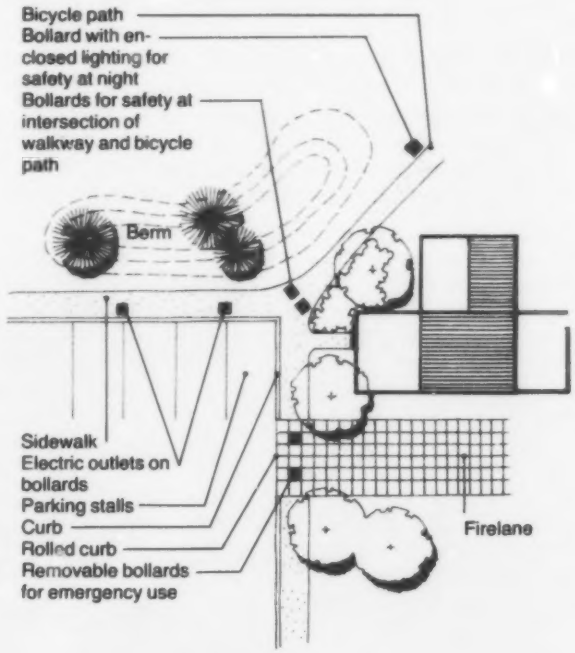


Fig. 140 Various uses of bollards.

Fig. 141 Carved wooden bollards are well suited to this site design.

If bollards serving electrical automobile block heaters are not properly placed, they can be dangerous and hard to maintain. For example, if they are situated on the far side of an adjacent sidewalk, then pedestrians will have to walk around or over the electrical cords that connect the vehicles to the bollards. One solution would be to widen the sidewalk and place the bollards on the vehicle side of the walkway; however, if they are located too close to the curb they can be easily damaged by vehicles.

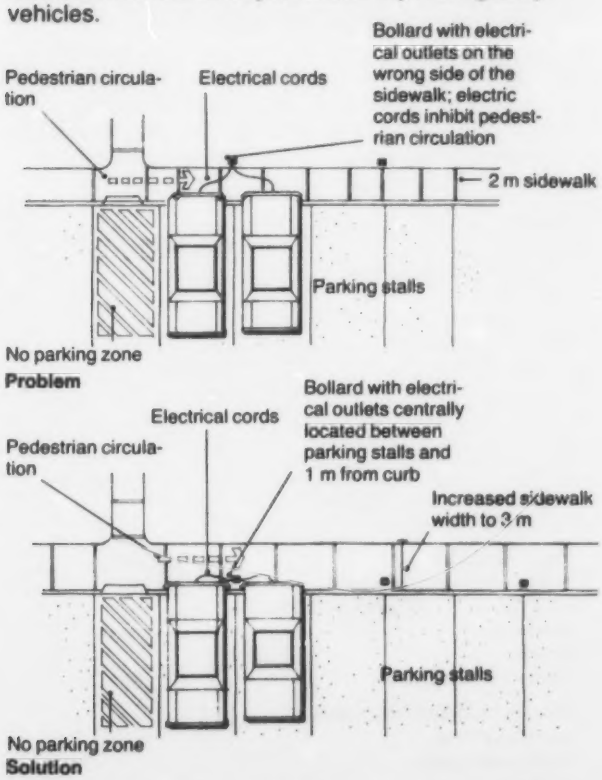

Pedestrian circulation
Electrical cords
Bollard with electrical outlets on the wrong side of the sidewalk; electric cords inhibit pedestrian circulation
2 m sidewalk
Parking stalls
No parking zone
Problem
Electrical cords
Pedestrian circulation
Bollard with electrical outlets centrally located between parking stalls and 1 m from curb
Increased sidewalk width to 3 m
Parking stalls
No parking zone
Solution

Fig. 142 If they are not carefully placed, bollards with electrical outlets can interfere with pedestrians on the sidewalk.

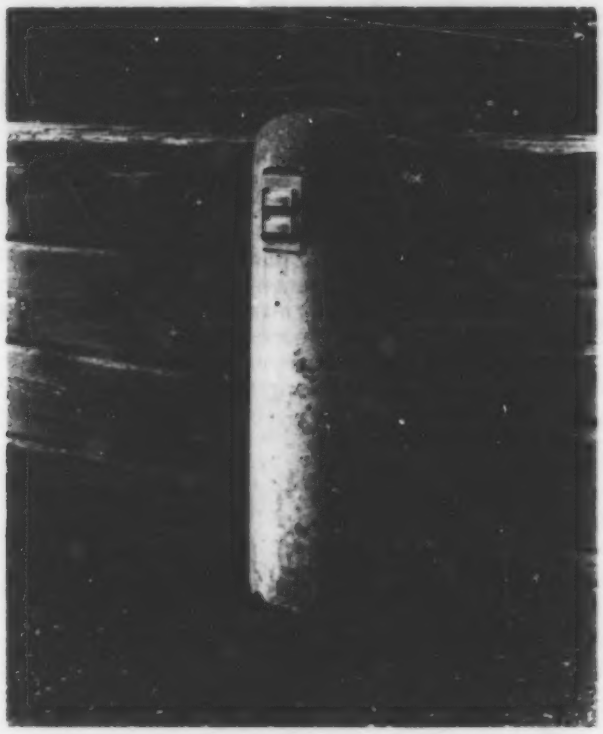


Fig. 143 An example of a parking lot concrete bollard with electrical outlets.

Play structures and the ground around them often are the most active outdoor place in a housing development. These valuable recreational features must be designed and constructed for a variety of uses and users. For more details refer to *Play Spaces for Preschoolers*, (Ottawa: Canada Mortgage and Housing Corporation, 1978, NHA 5138) and *Play Opportunities for School-Age Children, 6 to 15 Years of Age*, (Ottawa: Canada Mortgage and Housing Corporation, 1980, NHA 5318).

Play structures come in a variety of styles and sizes from specialized manufacturers. Individually designed play structures are generally more expensive than pre-manufactured ones. The most common type of play structure found in family-orientated housing projects is built of timber bolted together in a variety of sizes and shapes. All kinds of games can be played on them and they are normally strong enough to survive heavy use with a minimum of damage. Spare parts are usually available from the manufacturer. They are not difficult to maintain if they are properly installed; however, surveillance is necessary to prevent vandalism.

The sand or other play surface below and around the structure should have an edge border to prevent the loose material from being scattered onto nearby lawns or sidewalks. The edge can be made of timber, pre-cast concrete blocks, or cast-in-place concrete curbs.

Fig. 144 Children's play structures are valuable amenities that should be designed and constructed to accommodate the age-group most likely to use them. They also must be built to withstand vandalism.

Water features are not often incorporated into the landscape design of Canadian housing developments; they are expensive to build and maintain, and the summer is relatively short. Naturalistic pools, ponds and lakes are in a different category than decorative fountains, and are designed to appear as natural landscape features. Their design is influenced by the local climate, soil conditions, use, budget and the housing project's marketing concept.

Fig. 145 A fairly simple circular pond design enhances the communal space of this housing development.

Pools and fountains on roof decks add greatly to the attractiveness of the communal space. They must be built carefully to ensure that leaks do not develop and that the structure is strong enough to withstand the weight of the water. The water should be circulated by a pump and filter system to prevent it from stagnating. A design checklist for water features consists of:

- **Design**
  purpose
  naturalistic or geometric
  scale
  size, shape
  summer, winter use
  maintenance
- **Materials**
  cast-in-place concrete
  precast concrete
  stone
  brick and tile
  metal and plastic
- **Technical Details**
  waterproofing membranes
  water source, natural or mechanical
  overflows
  drains
  filters and cleanouts
- **Mechanical and Electrical**
  pump systems
  equipment space
  controls
  lighting
  safety.

Fig. 146 Pools are very attractive amenities, but require a great deal of maintenance.

4.5 SITE LIGHTING

Site lighting should be seen as a primary element of landscape design. It performs a variety of functions, such as improving the night-time visibility of signs, house numbers and recreational areas, and illuminating outdoor steps and walkways. A lighting plan should be developed with a specialist who is familiar with the various lighting intensities required for specific locations. Particular attention should be paid to operating costs, physical attractiveness, and the possibility of the lights being vandalized.

Fig. 147 Lighting standards (poles) and fixtures should be as attractive in the daytime as they are at night. Here, site lighting complements the housing project's overall visual character.

Light fixtures should be made of materials which are hard to vandalize; weather resistant for year-round exposure to rain, snow and sun; well-built and anchored to withstand storms; secure, durable and rust-resistant for permanence and attractiveness; self-draining to quickly get rid of rain and melting snow; shielded so that the light source is not visible; and easy to install and maintain.

A lighting system controlled by an automatic on-off switch saves energy and reduces operating costs. Avoiding strong light intensities and limiting the number of fixtures also conserves energy.

There are several ways of illuminating a site: "accent lighting" consists of lighting along shrub borders to display night-time colours and textures; "up-lighting" describes landscape lighting where the light source is usually near the ground and shining upwards in order to illuminate trees, fences and signs; "down-lighting" refers to a light source at eye-level or above that is used to illuminate the ground or other site elements.

All lighting should tend to shine down to avoid unnecessary glare. Light standards and fixtures should be designed to scale and in visual character with the housing project. It is a good idea to use similar or complimentary materials for the standards and fixtures as the buildings and other site features.

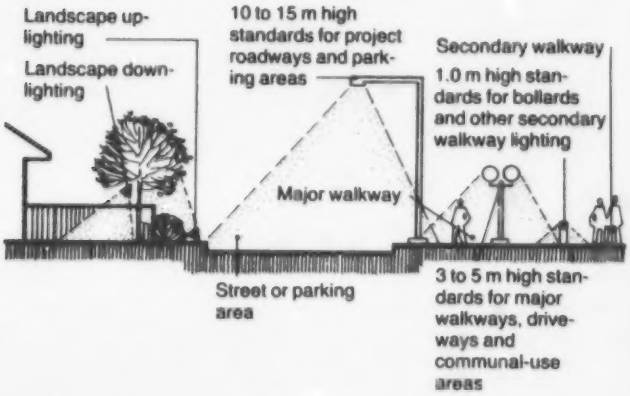

Landscape up-lighting
Landscape down-lighting
10 to 15 m high standards for project roadways and parking areas
Secondary walkway
1.0 m high standards for bollards and other secondary walkway lighting
Major walkway
Street or parking area
3 to 5 m high standards for major walkways, driveways and communal-use areas

Fig. 148 Purpose, functional intent and aesthetics should be kept in mind when determining size of lighting fixture and standard (pole).

4.6 SIGNAGE

There are four basic categories of signage:

- identification — identifies project by name, address and logo; for example, a large entrance sign
- directional — used to indicate directions to buildings, dwelling units, parking lots, recreational areas and traffic circulation
- informational — provides information about the site layout, such as where to find visitor and tenant parking
- regulatory — gives operational restrictions and warnings, such as No Parking and Stop signs.

Signs should be designed to complement the visual character of the housing project; this can be achieved if similar materials and a uniform design are adopted. To maintain unity and clarity, design guidelines should be carefully developed before the project's signage is manufactured. The following two photographs of signs should be studied in relation to Figure 151, an example of typical design guidelines for site signage. Essentially, the guidelines attempt to define a sign's purpose, clarity, convenience and order.

Fig. 149 Overcrowded signpoles cause confusion and detract from a development's visual character.

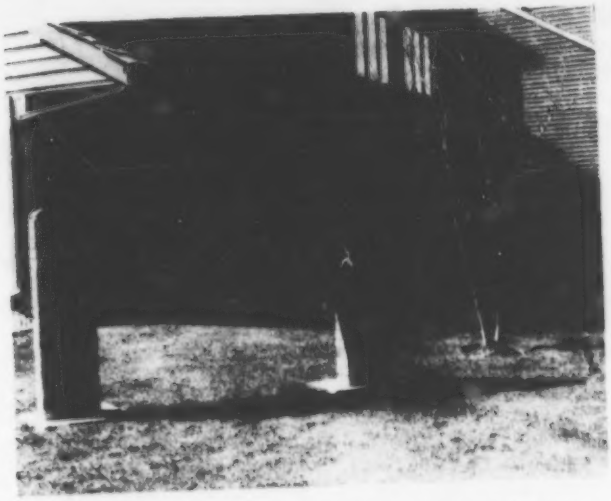


Fig. 150 Project identity is an important function of signage. Additional landscape features, such as berms, plant materials and lighting, can make a sign more attractive, improve its readability and better relate it to its surroundings.

Fig. 151 Typical design guidelines for site signage.

Subject/Intent	Design Objectives
Location: the relationship between the natural and man-made elements of a site and the effect of signage placement	· ensure that signage does not clash with physical surroundings · avoid obstructing important views · place signs where they can readily be seen by approaching vehicular and pedestrian traffic · do not attach signs to trees or other natural features · integrate signs with the building and landscape design · avoid signage congestion.
Form: a relationship to the shape, style and design proportions of adjacent buildings and landscape features	· it should be well-proportioned · the sign panel and shape should be pleasing to look at · it should conform to the project's character.
Scale: the size relationship of a sign to a person, vehicle, building, group of buildings, or the rest of the site	· the dimensions of the sign must be in scale with the functional service it performs and the physical site development around it · ensure that the individual parts of the sign are in scale with each other · avoid abrupt changes in size from one sign to the next · use surrounding landscape features as a scale reference to determine the size of the signage.
Materials: all the elements required to produce a sign. Preferred materials include wood, stone, brick, painted steel, exposed aggregate, and concrete with a surface texture	· materials should be durable and resistant to vandalism · sign and building material should be complementary · a limited number of materials should be combined in an attractive manner · materials should enhance the overall landscape design.
Colour: the range or palette of colours used as the signage	· the colour palette should reflect the colours for the project as a whole · natural earth tones, which blend with the landscape, are preferred · avoid luminous colours · use primary or bright colours sparingly · use a limited number of colours in any sign.
Message: the specific words and symbols on the sign	· the typographical style, symbols and format should be attuned to the message · the message should be brief · the number of words on the sign and their size should relate directly to the importance of the message, and the distance from which the sign is to be viewed. If the sign will be seen from a moving vehicle, the probable speed at which it will be travelling should be calculated · it should contain only those elements which are absolutely necessary to convey the message.
Lighting: both the light source and its intensity as it relates specifically to illuminating the sign	· avoid conspicuously glaring light sources · provide a light source in scale with the signage · light the message, not the background · provide a relatively vandal-proof light fixture.

4.7 SUMMARY CHECKLIST

Have the following been considered in choosing the hard materials: their availability, attractiveness, how easy or difficult they will be to maintain, and the costs of construction and maintenance? (Refer to Section 4.1)

Have the following been kept in mind when selecting paving materials: purpose, cost and availability, appearance, durability, safety, noise, light reflectivity, maintenance and subsoil drainage characteristics? (Refer to Section 4.2)

Do walls, fences and screens fulfil the functional requirements of enclosure, privacy, territory, ownership delineation, visual screening, climate control, noise abatement, security and ease of maintenance? (Refer to Section 4.3)

Are the walls and fences physically appealing, in scale and in visual character with adjacent buildings and site features? (Refer to Section 4.3)

Are garbage enclosures designed and constructed adequately to screen garbage bins, and are site locations, grading features and planting incorporated to improve their appearance? (Refer to Section 4.3)

Is the site furniture safe, functional, attractive, easy to maintain and durable, and can it be used by disabled persons? (Refer to Section 4.4)

Is there enough outdoor lighting to discourage vandalism, to provide security zones and to illuminate street signs, house numbers and walkway grade changes? (Refer to Section 4.5)

Is the site signage easy to read? Does it complement the project's visual character? Are all four basic categories of signage necessary? (Refer to Section 4.6)

Have design guidelines been developed for the housing project's signage? (Refer to Section 4.6)

CHAPTER 5 — PLANT MATERIALS

The success of a site development is generally affected by the materials which are chosen to turn the layout and grading design into a physical reality. This chapter concentrates on plant materials and will investigate functional applications, aesthetic values, growth requirements and plant selection.

5.1 FUNCTIONAL APPLICATIONS

The planting of trees, shrubs, vines and groundcovers, as part of a landscape design, serves a variety of functions:

- control of light, shade and glare
- control of wind and snow
- control of pedestrian traffic
- screening and visual control
- control of erosion.

Probably the most important use of plant materials as part of landscape design is the way they create and define the site's usable spaces. It is important to understand that plants take up space and therefore can be used to create outdoor walls, rooms and other defined spaces.

Fig. 152 An example of plants used to define spaces and control pedestrian circulation.

Plants can effectively enclose private space; a hedge around a patio is one example. They are often the most visually unifying element within a site development. It is important that planting be coordinated with all other aspects of the landscape design to reinforce the overall concept. Planting can be combined with hard landscape materials such as fences, walls and garbage enclosures to obtain the most functional, appealing and cost-effective results.

Fig. 153 Plants have been well placed here to reduce the amount of long continuous fence that can be seen.

Fig. 154 A combination of planting and fencing which makes an outdoor living area more private and grass maintenance unnecessary.

Plants can effectively reduce the glare caused by sunlight reflecting off buildings and streets, automobile headlights, safety lights and illuminated signs. The number, size, type, density and location of the plants influence how successfully the light reflection can be controlled. The positioning of the plant is critical for decreasing light glare; ideally, it should be set directly between the viewer and either the source or the reflecting surface. Plants near windows may effectively reduce the amount of sun which floods into the dwelling in summer, and makes stationary and moving night lights less intrusive throughout the year. Deciduous plants are ideal for blocking summer sun while allowing sunlight to enter the windows during the winter.

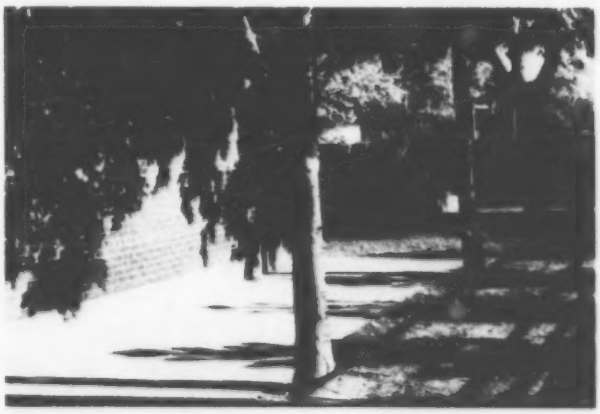


Fig. 155 Trees planted next to this building reduce glare and provide shade.

Planting trees around or within parking lots is generally a good way to lessen glare and provide shade for parked cars. If there is insufficient planting near pools to absorb the bright sunlight, the reflection from the water can be annoying. It may be impossible to plant around a pool or fountain without destroying views, but if the planting can funnel wind onto the water, the resulting rippling of the surface water will decrease reflection and glare.

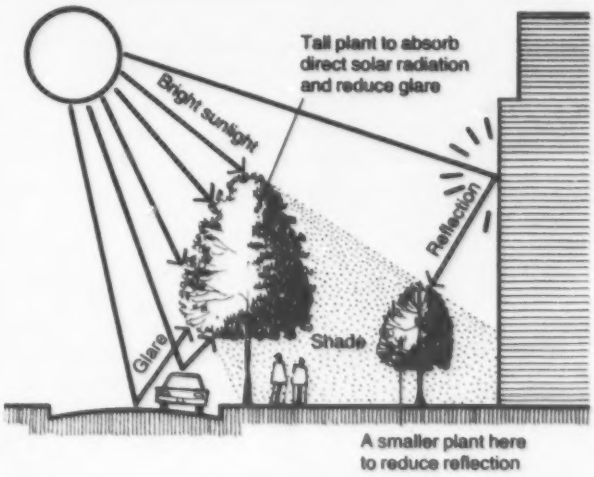
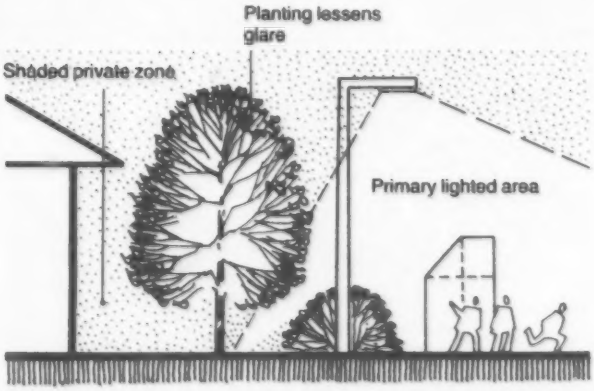


Fig. 156 Plants can be strategically placed to reduce the sun's glare and reflection.



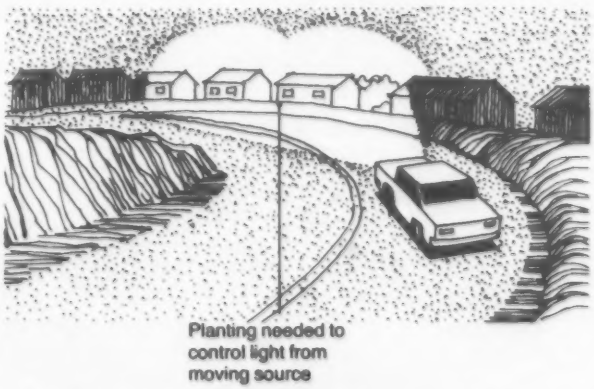


Fig. 157 Planting to control glare from stationary and moving light sources.

Plants and fences also control wind and snow. Plants obstruct, guide, deflect and filter wind. Massing together both deciduous and evergreen trees and shrubs produces a solid barrier which can effectively reduce wind velocities. The side of a housing project that is exposed to the prevailing winter winds should be protected by a windbreak of some sort. It will help to conserve energy in the building.

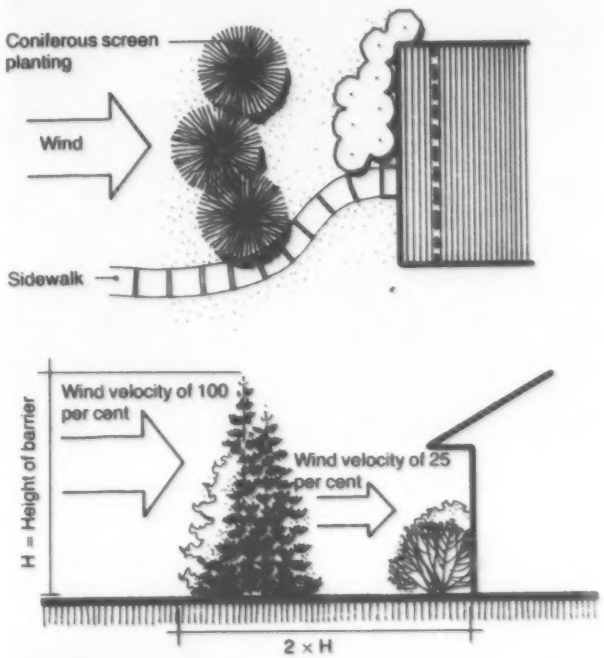


Fig. 158 A dense screen planting composed of six-metre tall coniferous trees will reduce wind velocity to 25 per cent leeward of the barrier for up to a distance of twice the height. Gary O. Robinette: *Plants/People/and Environmental Quality* (Washington, D.C.: U.S. Department of the Interior, 1972).

Drifting snow, even when the fall is not deep, is a hazard for pedestrians and becomes expensive to clear away. Closely spaced rows of trees or shrubs, with or without fencing, can help to control snowdrifts and save money. Generally, increased snow deposits occur downwind for a distance of about five to six times the height of the barrier. Gaps in windbreaks normally remain clear of snow because wind accelerates through these openings and blows the snow away.

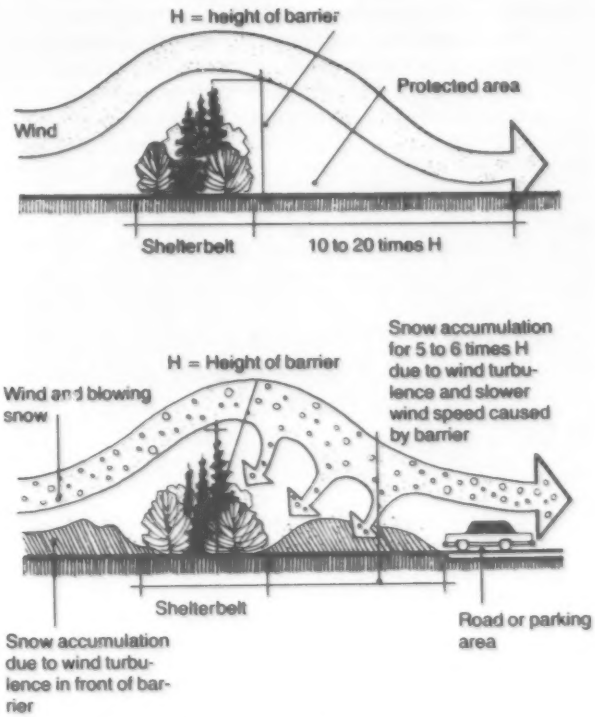

H = height of barrier
Protected area
Wind
Shelterbelt
10 to 20 times H
Snow accumulation for 5 to 6 times H due to wind turbulence and slower wind speed caused by barrier
H = Height of barrier
Wind and blowing snow
Shelterbelt
Road or parking area
Snow accumulation due to wind turbulence in front of barrier

Fig. 159 Typical effects of vegetative shelterbelt planting to control wind and snow on an exposed site. Generally, turbulence or slowing of wind that is carrying snow will cause it to be deposited at that point.

Although a major function of planting is to control pedestrian circulation and define property boundaries, it should be emphasized that a good site layout is the most critical element for satisfying the needs of residents. Planting should simply contribute to the functional and aesthetic aspects of the site layout; it should not have to be the principal means of controlling traffic. For example, plants may be put down at key locations to discourage pedestrians from taking short cuts across lawns, but it should not be necessary to line most walkways with them. Dense hedges or mass shrubs at least one metre tall are very effective physical barriers to control pedestrian circulation. However, plants lower than one metre will discourage most pedestrians and indicate ownership by illustrating a break between private and communal space. Similarly, rows of deciduous trees with branches removed to above eye level can suggest a barrier and may be safer, since molesters cannot hide behind them as easily as behind shrubs or coniferous trees. Nevertheless, coniferous trees are still preferred for circulation control because of their sharp texture, rigid form and year-long visual screen.

Fig. 160 A dense hedge here controls pedestrian circulation and lends privacy to dwellings nearby.

Fig. 161 Coniferous planting, in conjunction with landforms, emphasizes the pedestrian circulation route.

Another major attribute of planting is that it screens unsightly areas, such as garbage collection bins and parking lots. Adjacent land uses that may deserve to be screened are commercial sites, parking lots, roads and storage areas. When plants are chosen for the screen, consideration should be given to the size of the object that requires screening, its distance from the observer and whether the observer is moving or stationary.

Fig. 162 This mass planting of trees and shrubs is an effective and attractive method of screening a housing project from busy roads and parking areas.

Fig. 163 These tall hedges lend privacy to outdoor living areas.

Plants do not have to be used solely to screen objectionable views but can also be used to accentuate pleasant ones. By carefully locating plants, a good view or site feature can be framed for the viewer.

Erosion is most effectively controlled if the factors that contribute to it are fully understood. Planting, especially grass and other groundcovers, can help preserve the soil on steep slopes. Groundcover plants have fibrous and shallow root systems which effectively hold the soil particles together, while the upper part of the plant reduces the speed of surface water run-off. The leaves of the plants also break the velocity of falling rain, which otherwise can loosen soil and accelerate erosion. Mulches that provide a cover to prevent wind and water from dislodging the soil particles are also useful. Section 6.1 provides additional information on erosion.

Fig. 164 Mass shrub planting along this steep slope helps reduce erosion and sedimentation.

Grass can be a very effective and economical way to control erosion, although it should not be planted on slopes exceeding 33 per cent (1:3). Sodding is generally the best way to ensure a rapidly established groundcover that will stop erosion; on a steep slope, the sod should be pegged to stop it from slipping. If possible, terracing or other mechanical methods of erosion control should be combined with planting to counteract erosion. Mass shrub planting along slopes is an alternative way of checking erosion; if the correct plants are used, they will need less long-term maintenance than grass.

Fig. 165 Because this slope is so steep, grass should not have been used to stabilize the embankment. Moreover, placing loose sod over rock and poor soil obviously does not help the plants to grow.

5.2 AESTHETIC VALUES

Plants are frequently used to beautify a housing project. A good designer can exploit their varied colour and texture to add great interest and beauty to the site landscape. Coloured bark is especially attractive in a winter landscape; for example, Red Osier Dogwood has distinctive red twigs that contrast well with the whiteness of snow. A variation in foliage tones can highlight special plantings; for example, the blue tinge of Colorado Blue Spruce among deep-green pines. Plants change colour and form, so the designer should ensure that they are visually interesting in both summer and winter.

Fig. 166 A plant's colour, texture, size and form can be used to create a special effect in the site landscape.

Frequently, plants with special textures are set next to other special building materials or hard landscape features. The most obvious variations in plant size and form are between trees, shrubs, groundcovers and vines. Because every plant is a three-dimensional object, a variety of sizes and forms can be grouped to complement the functional applications of the site layout, as well as to display their unique "sculptural" qualities. Sizes and forms of each species must be carefully considered because each season plants undergo drastic physical changes which affect their appearance. It is possible that they may mature into quite a different form from when they were first planted.

Fig. 167 A variety of plant sizes and forms adds interest to this mass planting.

Each plant must be well integrated with its surroundings. If plant forms, sizes, colours and texture are too randomly combined, there is a danger of creating an incongruous site design. Plants should be chosen and placed to complement the architecture's visual character, as well as to relate in size and scale to surrounding buildings, landforms and the existing vegetation.

Informal planting means grouping plants according to their size, shape, colour and texture. These plants are often laid out in an irregular pattern to simulate a natural-looking landscape. Formal planting generally consists of placing plants so that they accentuate building entries and walkways; this style of design often sets plants in a line, such as closely trimmed hedges.

Plants naturally attract wildlife, especially if they bear fruits, nuts or berries. Birds and animals shelter and seek safety under them.

5.3 GROWTH REQUIREMENTS

The basic growth requirements which influence a plant's chances of survival on any site are:

- hardiness
- moisture
- light
- soil and nutrients
- stresses
- maintenance considerations.

Agriculture Canada has assessed the suitability of generally available plants relative to large-scale climatic variations; their map of Plant Hardiness Zones is widely accepted as a general guide to plants' hardiness (see Figure 168). Since variations in microclimate, salt spray, air pollution and Chinook winds further decrease a plant's hardiness, a local expert should be consulted to determine the best plants to use.

The Agriculture Canada Plant Hardiness Zones comprise ten zones numbered from 0 to 9; each zone is composed of sub-zones 'a' and 'b'. Each sub-zone 'a' is slightly more harsh to plant material than area 'b'; the lower the number of the zone, the more hostile the climate. The harshest climate is the Arctic Zone Oa, where temperatures frequently drop below -40°C during the winter. In contrast, the mildest zone of 9a is found in portions of southwestern British Columbia, where temperatures rarely fall below 0°C. Generally, plants will survive in all zones which are milder than those for which they are rated. For additional details on temperature variances across Canada, refer to both Figure 4 and Appendix B.

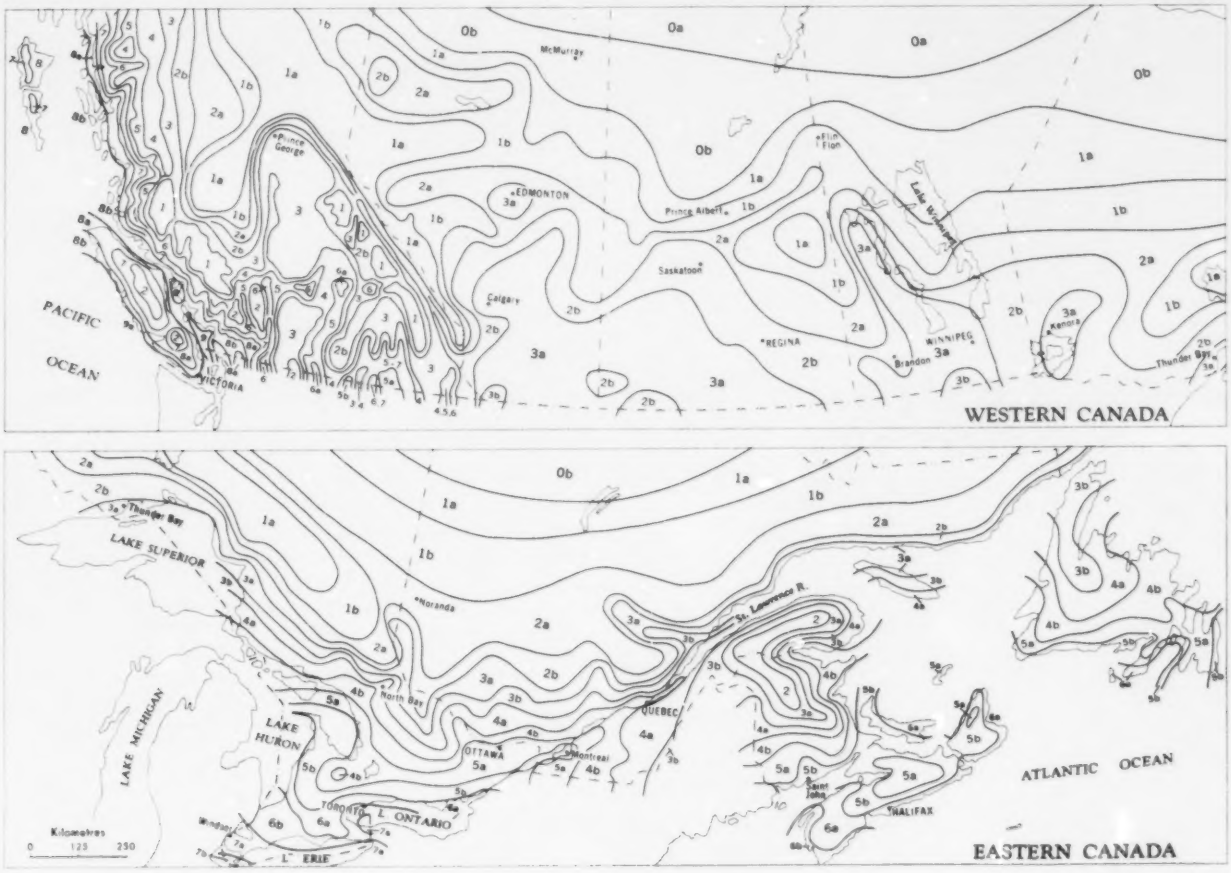


Fig. 168 Plant Hardiness Zones. Source: Agriculture Canada, Ottawa.

The scarcity or overabundance of soil moisture has a major effect on plant losses or poor growth. An adequate water supply should be provided at various locations on the site so that plants can be watered conveniently and regularly. This is particular important for evergreens, which require a lot of watering in the fall to ensure that they survive the winter.

Excessive soil moisture can be caused by a high water table, or poor soil drainage brought about by dense soils or inadequate surface drainage. Plants have different moisture requirements; for example, pines cannot tolerate continuously damp or high water-table locations, whereas willows thrive in the same conditions. If the soil is too saturated, a subsurface drainage system can be installed.

If drier conditions prevail, the soil's moisture retention can be improved by incorporating clay topsoil and mulches, reducing run-off velocity to allow more surface water to penetrate the ground, and installing an underground irrigation system. If an irrigation system is needed, it should be recognized early in the design process, when the site analysis information is being analyzed. Usually, the larger the site development, the more economical an underground sprinkler system is. Underground sprinkler systems are being installed quite frequently in the drier regions of Canada, where they help to reduce maintenance and plant replacement costs. For details on precipitation variances across Canada, refer to Figure 5 and Appendix B.

Fig. 169 Underground sprinkler or irrigation systems are usually installed after final grades are established but before planting or seeding takes place.

All plants need light. Many plants need full sunlight to flower or produce fruit, but others may be scorched if they are exposed directly to the sun. These plants are better suited to shady conditions and should be set next to buildings, fences and other plants. The light intensity and the number of sun hours vary across Canada. As a result, plants that require shade to thrive in one region may require full sunlight in another. For details on hours of bright sunshine per month across Canada, refer to Figure 6 and Appendix B.

Soil supplies a plant with nutrients, including water and oxygen, for its growth and reproduction. Since plant root systems are anchored in the soil, its properties of texture, structure and porosity greatly affect the plant's growth. Texture is a term that refers to the "feel" of a soil when it is rolled between the fingers; sandy soils are coarse and gritty, while clay soils are smooth and sticky. More technically, texture is defined by the content of sand, silt and clay particles found in a given sample. Soils with high sand or gravel content are porous, have a low water-holding capacity but provide good drainage. Conversely, soils with a high silt content have a greater water-holding capacity as well as a wide range of minerals. The proportion of clay particles in a soil is most important since they are a storehouse for plant nutrients and a major determinant of the soil's water-holding capacity. The concentration of clay particles also directly affects the swelling, shrinking and stickiness characteristics of a soil.

Soil structure refers to the physical arrangement of mineral and organic particles into aggregates of different shapes, sizes and porosities. An ideal soil structure affects the movement of air and water, as well as increases the soil's resistance to erosion.

Soil porosity refers to the total pore space that is filled with either air or water. Porosity generally determines soil drainage, the relative volumes of water or air that can be held by the soil, and the extent of root penetration. Good soil porosity can be destroyed if the soil is compacted by heavy equipment during construction; it will then have to be restored by mechanical means.

A soil's most important chemical characteristic is its degree of acidity or alkalinity. Whether it is acidic, neutral or alkaline greatly affects the soil's suitability as a growing medium for various species of plants. The acidity level of a soil is dictated by the amount of dissolved hydrogen present in it; this is represented as pH. The pH scale varies from acidic to alkaline on a range from 0 to 14, with 7 being neutral. Generally, a soil with a pH below 6.6 is acidic; if it is more than 7.3 it is becoming noticeably alkaline. From pH 6.6 to 7.3 is generally neutral and a good growth medium for plants; but plants will also grow well in mildly acid soils of pH 5.5 to 6.5.

The acidity tolerances of particular plants usually include a span of two or three pH factors. If existing soil and subsoil acidity is a problem, limestone can be added to increase the pH value, while aluminum sulphate, powdered sulphur, or peat moss will make the soil more acidic (by lowering the pH). Where continued maintenance by a trained horticulturist is not assured, plants should be chosen on the basis of the existing soil pH.

The major nutrients provided to plants through the soil are nitrogen (N), phosphorus (P), and potassium (K). These three elements comprise the bulk of the nutrients sold as commercial fertilizers; smaller concentrations of sulphur, calcium, magnesium and boron are also included. If there are excessive or insufficient nutrients in the soil, plants will not grow as well. Nitrogen is the most important nutrient for continued plant growth; its presence is evident in dark green plants and lawns. Phosphorus promotes vigorous growth and stimulates root and seed development. It is most generously present in a soil pH range between 5.5 and 7. Potassium exists in most soils with other elements; its precise biochemical function is unclear, but it makes plants hardier and more resistant to disease.

Soil tests and analysis are available free or at a nominal cost from most provincial departments of agriculture. These analyses normally include suggestions for improving fertility and altering soil pH. Similar services are provided by independent soil-testing laboratories, but usually at a higher price. If the site development is extensive and soil conditions are known to vary considerably, it may be advantageous to have the testing agency take the soil samples and submit a complete analysis.

Proper plant selection and location is important to avoid subjecting plants to unnecessary stresses, such as:

- wind exposure
- frost pockets
- insects and diseases
- air or soil-borne salts
- air pollution
- vandalism
- snow removal and storage
- chemicals, such as broad-leaved weed killers.

A number of additional stresses may arise which will jeopardize even the hardiest plants. For example, construction wastes, such as tar, muriatic acid, asphalt and concrete, can contaminate soils and cause poor drainage. This, in turn, may cause a deficiency or excess of surface run-off, thereby supplying the plant with too much or too little water. Construction traffic, storage of materials, or severe grading changes may also damage the root systems of existing vegetation.

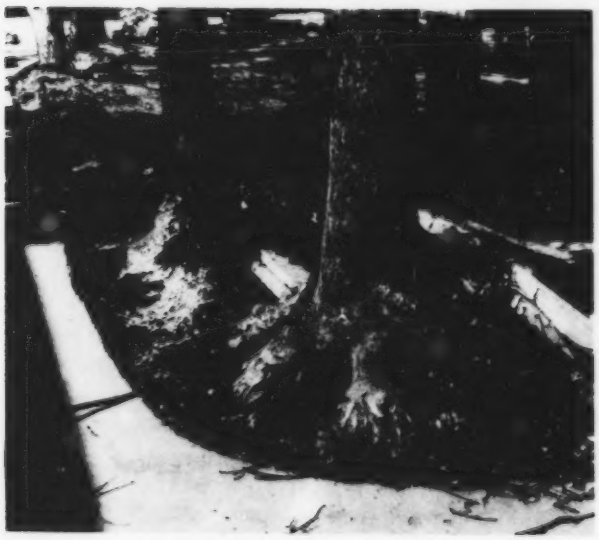


Fig. 170 Methods of preventing root damage, such as placing the sidewalk further from the tree and using tree mounds, should have been considered before site construction began. With this amount of root damage and other plant stress, there is little chance of these trees surviving.

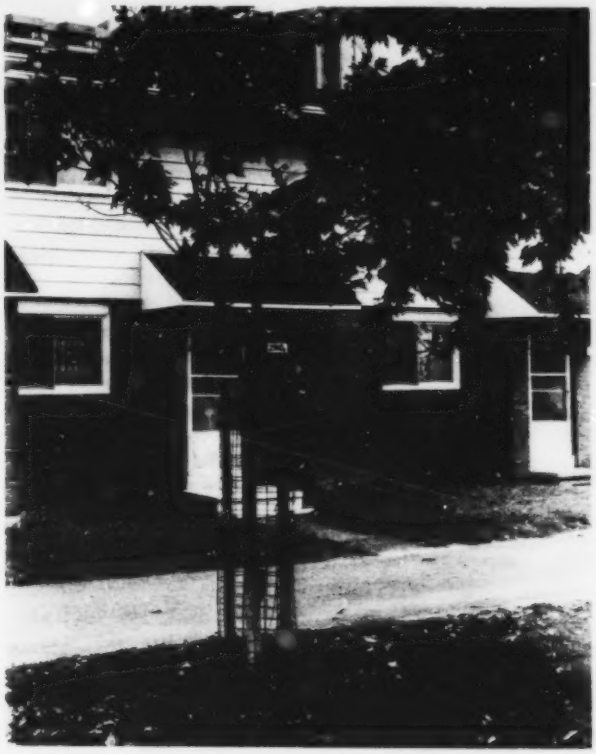


Fig. 171 A tree which has been protected from vandals, maintenance equipment and animals by trunk wrapping and a wire tree guard will have a better change of survival.

Extra watering and attention must be given to most plants during their first few years in order to become established. Later, maintenance is necessary because the plants undergo various stresses. For example, trees and shrubs require pruning to remove old, weak and diseased stems or branches. For details on maintenance programs or procedures, see Sections 6.4 and 6.5.

5.4 PLANT SELECTION

The cost and availability of plants vary widely across Canada. Ordering plants which are not available locally and which have to be brought in from other regions is expensive. Factors which influence cost are size (caliper, height, spread), type (deciduous, coniferous), condition (single or multi-stem; basket or containers) and availability. Factors which then influence availability are market demand, number and location of distributers, hardiness, growth characteristics and maintenance requirements.

A "plant list" and a planting plan should be prepared, which illustrate the location, types, sizes and conditions of plants to be used in the site development. For the sake of accuracy and to maintain a certain amount of uniformity, plant specification should always include both the botanical name (Latin) and the common name (English/French). Specification of common names only is not recommended because the same species may be referred to by several different common names in the same region, and the same common name may be used to describe different plants. For simplicity, plants are usually listed by general horticultural divisions, such as deciduous trees and coniferous shrubs. These categories are standard for landscape drawings and specifications, and form the basis for the Canadian Nursery Trades Association's *Guide Specification for Nursery Stock*. This publication also describes branching, root conditions, forms, heights and other details for each category and size of plant supplied by Canadian nurseries. A planting plan should include "notes", which give installation and planting details, advice and warnings, staking and guywire techniques, and recommendations for preserving existing plant material. A "plant list" should also be included, with the following important information:

- botanical name
- common name(s)
- quantity (numbers of each plant used)
- size (caliper, height, spread)
- spacing (distances between plants)
- condition (stem condition, trunk wrapping, container stock)
- remarks/comments.

The following five figures list dependable plants which are available in most parts of Canada and are relatively low maintenance. Unless otherwise stated under "Remarks", these plants will tolerate both full sunlight and light shade; low to medium fertility; 5.5 to 6.5 pH; moist to well-drained soils; and light clay to sandy soil textures. The information listed under "Hardiness Zones" refers to the Canadian Plant Hardiness Zone Map, Agriculture Canada, illustrated as Figure 168.

The following abbreviations are used in the "Remarks" column:

Shade: tolerates moderate shade, such as north face of building
Sun: requires full sun for at least four hours per day
Salt: tolerates some wind-borne salt
Salt X: sensitive to wind-borne salt
pH5: requires acid soil
pH7+: requires or tolerates alkaline soils
Wet Soil: tolerates heavy or poorly drained soils and requires constant moisture supply
Dry Soil: requires light, well-drained soils and tolerates drought
Sterile: without the capability to reproduce; will not sucker or produce fruit
Soil: can tolerate low fertility, soil nutrient levels
Specimen: the plant has a striking form or colour that renders it suitable for planting in a prominent place.

Fig. 172 Deciduous Trees.

Hardiness Zones	Botanical Name	Common Name	Mature Height (m)	Remarks
1b	Acer negundo	Manitoba Maple, Box Elder	12	weak wood; fast growing; wet soil
1b	Larix decidua	European Larch	15	sandy; moist soil; needlelike foliage
1b	Larix laricina	Tamarack	25	very hardy; golden fall colour; very open
1b	Salix pentandra	Laurel Leaved Willow	12	aphid pest problem; wet soil; high maintenance
2	Betula verrucosa 'gracilis'	Cutleaf Weeping Birch	10	small leaves; hanging branches
2a	Betula species	Birches	16	serious insect pests; winter interest
2a	Malus baccata	Siberian Crab Apple	6	narrow form available; edible fruit
2a to 4	Populus species	Poplars	6-22	fast growing; short-lived; variety of forms
2a	Sorbus decora	Showy Mountain Ash	6	interesting fruit; shrubby form
2b	Elaeagnus angustifolius	Russian Olive	7	silver foliage; suffers winter damage
2b	Larix kaempferi	Japanese Larch	16	loses needles annually; fall colour
2b	Fraxinus nigra	Black Ash	16	few pests; fall colour
2b	Fraxinus pennsylvanica lanceolata	Green Ash	16	few pests, heavy soils, yellow fall colour
2b	Syringa amurensis japonica	Japanese Tree Lilac	6	few pests, large white blossoms, pyramidal
2b to 5	Malus, varieties	Hybrid Flowering Crab Apple	6	some sensitivity to fire blight disease
3	Sorbus aucuparia	European Mountain Ash	12	rounded form with open foliage
3a	Aesculus glabra	Ohio Buckeye	9	blossoms, shrubby form, orange
3a	Amelanchier canadensis	Shadblow Serviceberry	8	fall colour, edible fruit, white flowers in spring
3a	Celtis occidentalis	Hackberry	16	form like American Elm, disease resistant
3a	Sorbus aucuparia	European Mountain Ash	12	dry soil, interesting fruit
3a	Prunus padus commutata	European Bird Cherry	9	fast-growing
3a	Prunus virginiana melanocarpa	Chokecherry	7	shrubby form, single, white flowers
3a	Prunus maackii	Amur Chokecherry	6	winter interest, white flowers in May
3a	Ulmus pumila	Siberian Elm	16	short-lived, weak wood, fast-growing
3a	Acer saccharinum	Silver Maple	22	fast-growing, wet soils, weak wood
3a	Fraxinus americana	White Ash	19	heavy soil, purple or yellow fall colour
3a	Tilia cordata	Littleleaf Linden Lime	16	tolerates air pollution, densely branched
4a	Acer rubrum	Red Maple	19	red fall colour, moist soil, fast-growing
4a	Alnus incana	Speckled Alder	6	wet soil, dense dark green foliage
4a	Salix alba Tristis	Golden Weeping Willow	16	wet soil, aphids, aggressive roots
4	Ginkgo biloba	Maidenhair Tree, Ginkgo	16	highly resistant to disease, fall colour
5a to 6	Acer platanoides	Norway Maple	16	heavy shade, various foliage colours, forms
5a	Acer saccharum	Sugar Maple	22	fall colour, fast-growing
5a	Aesculus hippocastanum Baumannii	Baumann's Horse Chestnut	16	less fruit than common type, large flowers
5a	Cercidiphyllum japonicum	Katsura Tree	16	wet soil, few pests
5a	Gledistsia triacanthos Inermis	Thornless Honey Locust	16	creates light shade, foliage colours, few pests
5a to 6	Quercus species	Red, Scarlet, White and English Oaks	16-18	slow to medium growth, long-lived, specimen trees, some narrow forms

Fig. 172 continued

5b	Prunus serrulata	Oriental Cherry	7	various forms, fall colour, blossoms
5b	Catalpa speciosa	Northern Catalpa	16	fast-growing, conspicious white flowers
5b	Crataegus phaenopyrum	Washington Hawthorn	7	clusters of red fruit, thorns
5b	Magnolia soulangiana	Saucer Magnolia	8	striking spring flowers before leaves, needs winter protection
6a	Ailanthus altissima	Tree-of-heaven	16	fast-growing; sterile soils; pollution resistant; odorous
6a	Fagus sylvatica	European Beech	22	winter interest; long-lived; attractive flowers
6a	Liriodendron tulipifera	Tulip Tree	22	few pests; large flowers; specimen tree
6a	Platanus acerifolia	London Plane Tree	18	winter interest; pollution resistant
6	Cornus florida	Flowering Dogwood	5	shade; flowers
6	Acer circinatum	Vine Maple	7	fall colour
6	Cercis canadensis	Eastern Redbud	4	likes shade; pink flowers in spring

Fig. 173 Coniferous Trees.

Hardiness Zones	Botanical Name	Common Name	Mature Height (m)	Remarks
1b	Picea glauca	White Spruce	19	bright green to bluish green foliage
1	Picea mariana	Black Spruce	16	wet acid soil; unattractive at maturity
1	Pinus mugo	Mugho Pine	1-4	dry soil; needs pruning; good hedge
2a	Picea pungens	Colorado Spruce	16	bluish to green foliage; pollution resistant
2b	Abies lasiocarpa	Alpine Fir	17	blue/green; slow growing; narrow
2b	Picea abies	Norway Spruce	22	broad spread at maturity; attractive branching habit
3a	Pinus cembra	Swiss Stone Pine	9	specimen; slow-growing; disease resistant
3a	Pinus contorta latifolia	Lodge Pole Pine	19	narrow form; light shade
3a	Pinus ponderosa	Ponderosa Pine	19	drought resistant; fast-growing; platelike bark
3a	Pinus strobus	Eastern White Pine	22	sensitive to air pollution and dry wind
3a	Pinus sylvestris	Scotch Pine	16	tolerates air pollution; tan bark
3a	Thuja occidentalis	Eastern White Cedar	6	salt tolerant; many varieties less hardy; wet alkaline soil
4a	Abies concolor	White Fir	16	specimen; medium growth rate
4a	Abies koreana	Korean Fir	9	slow-growing specimen
4a	Pseudotsuga menziesii glauca	Douglas Fir	16	sensitive to air pollution; good windbreak
4b to 7	Chamaecyparis species	False Cypress	3	specimen plants; need humid conditions
6	Thuja plicata	Giant Arborvitae	10-20	various forms and colours; green foliage
4b	Tsuga canadensis	Canada Hemlock	9	wet alkaline soils; shade; long; slender
5a	Picea omorika	Serbian Spruce	16	narrow specimen plant; glossy green foliage
5a	Pinus nigra	Austrian Pine	16	specimen; will withstand urban conditions
5b	Chamaecyparis species	False Cypress	9	specimen; need well-drained, wet soil
6	Tsuga heterophylla	Western Hemlock	30+	good in high altitudes; humid weather; tallest hemlock; wet soils
7	Cedrus atlantica	Atlas Cedar	25	specimen; various colour forms

Fig. 174 Deciduous Shrubs.

Hardiness Zones	Botanical Name	Common Name	Mature Height (mm)	Remarks
2a	Acer ginnala	Amur Maple	3000-6000	needs acidic soils; fall colour
2a	Caragana arborescens	Siberian Peashrub	5000	excessive pod fruit produced; dry soil, pH 7.0
2a	Caragana pygmaea	Pygmy Peashrub	2000	spiny; dense; good barrier hedge
2a to 6	Cornus alba (varieties)	Dogwood	2000	interesting stem and leaf colours; shade or sun
2a	Cornus stolonifera	Red Osier Dogwood	2000	red stems; native; wet soil
2a to 5	Cotoneaster species	Deciduous Cotoneasters	1000-2000	good hedges, groundcovers; pH 7.0+
2a	Lonicera species	Honeysuckles	1000-3000	fast-growing; twiggy (disease - Witch's Broom)
2a	Myrica pennsylvanica	Bayberry	2000	sterile; attractive fruit
2a	Parthenocissus quinquefolia	Virginia Creeper	3000 high	vine or groundcover
2a	Potentilla fruticosa	Bush Cinquefoil	600-1200	many varieties, forms, flower colours; drought tolerant
2a	Prunus tomentosa	Nanking Cherry	2500	edible fruit; drought tolerant
2a	Ribes alpinum	Alpine Currant	1500	shade; dense form
2a	Rosa rugosa	Rugosa Rose	1000	spiny; good barrier plant
2a	Sorbaria sorbifolia	Ural False Spirea	1500	shade or sun
2a	Symphoricarpos albus	Snowberry	1000	drought tolerant; sun or shade
2a	Syringa species	Lilacs	1000-4000	various forms; flower colours
2a	Ulmus pumila	Siberian Elm	2000+	bushy tree - can form hedge, weak wood
2a	Viburnum trilobum	Highbush Cranberry	3000	edible fruit; shade
2b	Hippophae rhamnoides	Sea-Buckthorn	4000	winter interest; salt +; silver leaves; pH 7.0+
2b to 5	Physocarpus species	Ninebark	2000	good hedge; gold foliage form
2b	Prunus triloba	Flowering Almond	2500	large blossoms
2b	Rosa rubrifolia	Redleaf Rose	2000	good barrier plant
2b	Salix purpurea Gracilis	Purple Osier Willow	1000	grey-green foliage; purple stems; wet soils
2b to 4	Sambucus species	Elderberries	3000	vigorous, golden forms; edible berries; shade or sun
2b	Spirea bumalda	Low Spireas	1000	various flower and foliage colours
2b to 5	Spirea, varieties	Tall Spireas	1200-1800	bridalwreath-type spireas
3	Rhus typhina	Staghorn Sumac	7000	swift growth; good fall colour
3	Prunus x cistena	Purple-leaved Sand Cherry	5000	purple leaves; small white flowers
3a	Euonymus alatus	Burning Bush	2000	fall colour; pH 7.0+
3a to 4	Philadelphus species	Mockoranges	1500-3000	large white flowers; some foliage colours
3a	Viburnum lantana	Wayfaring Tree	3000-5000	dry soil; shade or sun
4	Amelanchier species	Serviceberries, Saskatoon	2000-8000	native; fall colour; many blossoms; edible fruit

Fig. 174 continued

4 to 6	Forsythia, varieties	Forsythia	1500-3000	early blossoms
4	Hypericum calycinum	St. John's-Wort	1000	wet soil; groundcover; yellow flowers
5	Acanthopanax sieboldianus	Five-leaf aralia	2000	sterile soil; tolerates pollution; spiny; shade or sun
5	Kerria japonica	Japanese Kerria	1000	stands dense shade; winter interest
5 to 6	Ligustrum species	Privets	1000-3000	shade or sun; good hedge; fast-growing; various foliage colours
6	Deutzia gracilis	Slender Deutzia	1000	compact; dense
6	Rosa multiflora	Japanese Rose	2000	spiny; dense
6	Acer palmatum (varieties)	Japanese Maple	3000	small; elegant leaves; variety of colours; needs shelter from wind

Fig. 175 Coniferous Shrubs.

Hardiness Zones	Botanical Name	Common Name	Mature Height (mm)	Remarks
1	Pinus mugo	Mugho Pine	1200-1400	sun; dry soil; salt
1b	Thuja occidentalis 'Emerald'	Emerald Cedar	to 3000	compact; pyramidal; bright golden foliage
2a	Juniperus horizontalis	Creeping Juniper	150	sun; dry soil; pH 7.0+; various foliage/ colours; good ground cover
2a	Juniperus sabina Tamariscifolia	Tamarix Savin Juniper	300-600	prostrate groundcover
2a	Juniperus sabina	Savin Juniper	600	sun; various foliage colours, good groundcover
2b	Juniperus chinensis Pfitzeriana Aurea	Golden Pfitzer Juniper	1000	sun; yellow tip foliage; good groundcover
2b	Thuja occidentalis Wareana	Siberian Cedar	4000	sun; salt
3a to 5	Juniperus chinensis	Chinese Juniper	1000-4000	sun; varied selections of heights; hardiness colour; good groundcover
3b to 4b	Juniperus scopulorum	Rocky Mountain Juniper	2000-4000	sun; various foliage colours
3b to 5b	Juniperus virginiana	Eastern Red Cedar	3000-5000	sun; very narrow forms
3a	Thuja occidentalis Woodward	Globe Cedar	1000+	round form; shade; salt
4b	Picea glauca Conica	Dwarf Alberta Spruce	1500	pyramidal; protect from winter sun
4b	Taxus cuspidata	Upright Japanese Yew	3000	columnar form; shade; salt
4a	Taxus cuspidata Nana	Dwarf Japanese Yew	1000	spreading form; shade; salt
5a	Juniperus communis	Common Juniper	1000	good groundcover
5b	Taxus x media	Hybrid Yews	1000	various forms, colours; shade; salt

Fig. 176 Broadleaf Evergreen Shrubs.

Hardiness Zones	Botanical Name	Common Name	Mature Height (mm)	Remarks
2	Arctostaphylos uva-ursi	Bearberry	100	slow to establish; groundcover; pink flowers
2b	Daphne cneorum	Rose Daphne	500	rosy pink flowers; needs snow cover on prairies
2b	Pachistima canbyi	Canby Pachistima	200	sun or shade; groundcover
3a	Yucca glauca	Spanish Bayonet	600	sun; pH 7.0+
3b to 6	Genista species	Greenweed	150-400	yellow flowers; good groundcover
3b to 8	Ferns, various	Ferns	500-2000	shade; moist soil; various pH
3b	Vinca minor	Periwinkle	200	shade; groundcover
5 to 7	Rhododendron species	Rhododendrons	600-1500	pH 5.0 −; shade; many varieties
6	Cotoneaster species	Creeping Cotoneasters	100-500	good groundcover; attractive berries; salt
6	Euonymus fortunei	Wintercreeper	200-1000	groundcovers and vines
6	Cytisus species	Broom	400-1000	sun; sterile, dry soil; good groundcover
6	Lavandula spica	Lavender	500	salt+
6	Mahonia aquifolium or repens	Oregon Grape	500-1500	thorny leaves; sun or shade
6b	Gaultheria procumbens	Wintergreen	600	groundcover; sun or shade; salt+
6b	Pieris japonica	Japanese Andromeda	1500-3000	shade; dense; compact form; coloured foliage
6b	Prunus laurocerasus	Laurel	900-2500	good tall hedge
6+	Erica and Calluna species	Heaths and Heathers	100-500	pH 5.0 −; attractive flowers; good groundcovers
7	Ilex species	Holly	1000-1500	salt+
7	Aucuba japonica	Japanese Aucuba	1000-3000	shade; attractive berries in winter; tolerates air pollution
7	Rhododendron japonicum	Japanese Azalea	500-1200	shade; moist soil; many varieties
7	Berberis species	Evergreen Barberry	500-1800	thorns; dense branching; sun; shade
7	Cotoneaster species	Upright Cotoneasters	to 3000	attractive berries
7	Elaeagnus species	Elaeagnus	3000	silvery leaves
8b	Camellia japonica	Japanese Camellia	3000	fall to spring flowering; shade

5.5 SUMMARY CHECKLIST

Have the potential plant uses of screening, preventing erosion controlling and circulation been fully utilized? (Refer to Section 5.1)

Have the colour, texture, size, form, and seasonal variations of plants been considered, and their relationship to their surroundings? (Refer to Section 5.2)

When selecting plants, has thought been given to the plant's hardiness, its moisture requirements, and the light, soil and nutrients it needs to grow? (Refer to Section 5.3)

Will plants be subjected to environmental and man-made stresses, such as wind exposure, frost pockets and other microclimates, insects and diseases, air or soil-borne salts, vandalism, chemicals, and snow removal and storage? (Refer to Section 5.3)

Will cost and availability affect which plants are selected? (Refer to Section 5.4)

CHAPTER 6—CONSTRUCTION & MAINTENANCE

Proper construction is essential to the functional and aesthetic success of a landscape design. The type and amount of long-term maintenance that will be necessary is also determined by the quality of construction, assuming that it is based on an appropriate site design. This chapter will deal with maintenance on the basis of programs, budgets and procedures. The control of erosion will also be investigated, including during construction.

6.1 EROSION CONTROL

Erosion problems can be severe during construction and must be considered during site layout and especially during the grading and material selection phases of landscape design. Any erosion problems which have not been resolved during design or construction become a maintenance concern.

Fig. 177 A terraced retaining wall with vegetation cover is a useful and attractive method of slope preservation. Here a potential erosion problem was identified and resolved before construction began.

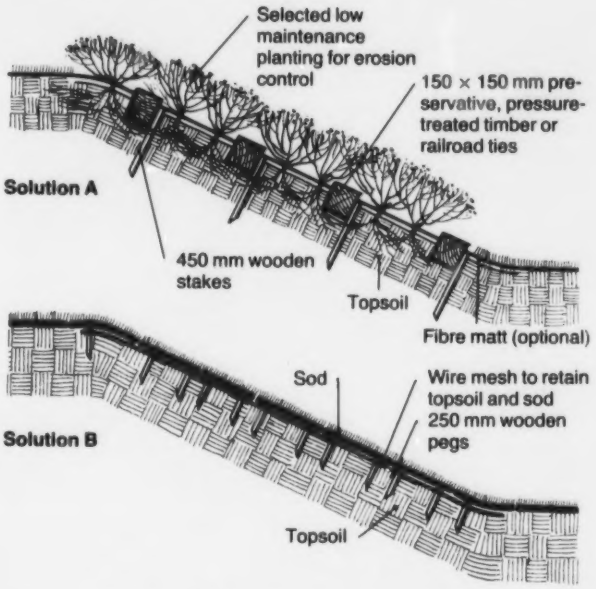


Fig. 178 Solution A consists of controlling erosion on a steep slope by using a combination of small shrubs and timber retainers; solution B consists of sod held in place with wooden pegs.

Erosion and sedimentation during site construction can be controlled significantly if certain goals are observed:

- steep slopes should be avoided
- bare soil should be exposed for the shortest possible time during grading operations
- the volume and speed of surface run-off should be controlled
- surface run-off should be slowed down, or temporarily held in a settlement pond, to allow soil particles to settle before the water leaves the site
- existing vegetation should be retained, particularly on slopes
- slope stabilization methods, such as retaining walls, gabions (metal mesh cribs), planting and stone covering, should be incorporated on slopes which are prone to erosion.

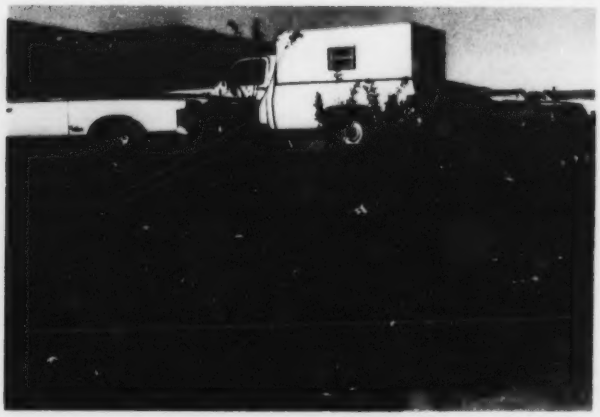


Fig. 179 A slope of exposed soil is vulnerable to erosion and may cause serious sedimentation problems.

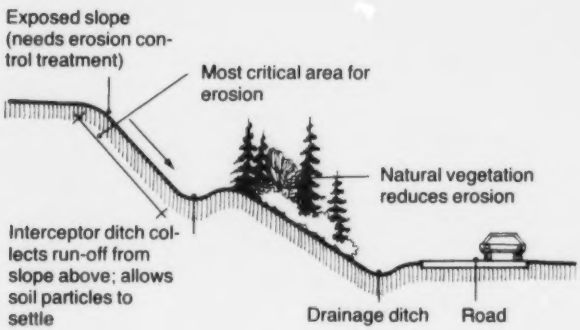

Exposed slope (needs erosion control treatment)
Most critical area for erosion
Natural vegetation reduces erosion
Interceptor ditch collects run-off from slope above; allows soil particles to settle
Drainage ditch
Road

Fig. 180 Surface water volume and speed is reduced by interceptor ditches that prevent the run-off from travelling down the entire slope.

Climate, vegetation cover, soil and slope all influence the severity of erosion and sedimentation. The two basic means of combating these problems are mechanical and vegetative. The mechanical method includes:

- site grading
- diversion techniques, such as berms and interceptor ditches
- retaining walls, including terracing
- timber cribs and gabions filled with stone
- stone covering (rip-rap)
- wire and burlap mesh as a soil cover
- run-off retention ponds.

Mechanical methods of reducing erosion and sedimentation are most successful if they are individually designed to solve a particular problem. Combining vegetative and mechanical methods of slope preservation is usually the most effective way of preventing erosion. Adding vegetation normally helps the visual appearance of slope stabilization projects. For additional details on erosion control with vegetation, refer to Section 5.1.

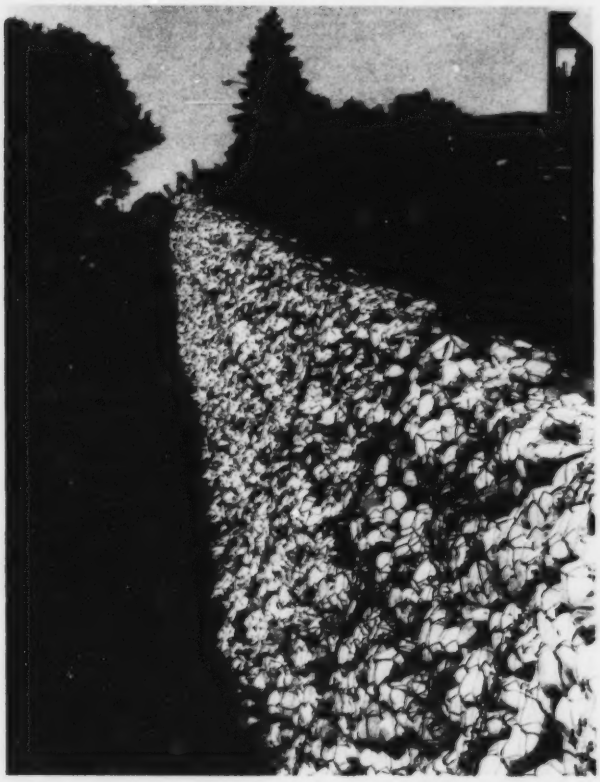


Fig. 181 An example of stabilizing a steep slope with gabions — wire mesh containers filled with stone. Because of their size and appearance, gabions are not often used on housing projects.

Fig. 182 This wall of large stones is an attractive and effective mechanical means of prevention erosion.

Fig. 183 Hand-placed granite blocks are used as a surface rip-rap along this bank; the material forms an effective barrier against the erosive action of the fluctuating tides, although it is a very expensive method of slope preservation.

6.2 CONSTRUCTION

Construction of the landscape design should be awarded to a qualified landscape contractor, experienced in all facets of layout, grading, hard materials and plant materials. If the size or complexity of the project warrants it, a qualified construction supervisor or landscape architect should oversee the construction. The owner will often hire a landscape architect to both prepare the landscape design and to supervise all of the site construction. Site construction should proceed according to landscape plans and specifications, and site problems should be avoided or dealt with efficiently.

Fig. 184 This sod-cutting machine is used on some site construction projects to replace damaged or dead grass with fresh sod.

Fig. 185 Hiring a landscape architect or other qualified site construction consultant would help to avoid unnecessary problems, such as these improperly installed guy wires that do little to support the trees from a strong wind.

There are two bases upon which bids for implementation of a landscape design may be presented by a number of prospective contractors; on a lump sum or unit price basis, or on a labour and materials basis, which includes cost-plus calculations up to a certain figure. Generally, on all but the smallest landscape projects, the lump sum method is adopted.

Proper tender documents are essential to the successful implementation of the landscape project. They must convey accurately and clearly the designer's intent and requirements concerning materials and workmanship. Tender documents will normally consist of the following:

- bid documents (instructions to bidders, bid forms and bid bond forms)
- contract forms (agreements, bond and insurance forms)
- contract conditions (general and supplementary conditions to the contract)
- technical specifications (detailed instructions for supply and installation of all aspects of the design)
- working drawings (plans and construction details of the landscape design).

The technical specifications and working drawings form the heart of the contract documents; they govern the layout and location of the landscape elements, the type and quality of materials, equipment and fixtures to be used, the quality of the workmanship, and maintenance periods and replacement guarantees. For plant materials, the source commonly referred to for technical specifications is *Guide Specification for Nursery Stock*, published by the Canadian Nursery Trades Association.

The contract documents should stipulate the specific materials and services to be supplied and installed, at the accepted unit prices. After a formal contract has been negotiated and signed, any additions or deletions to the originally specified scope of work must be done with official changes or addenda that become part of the contract.

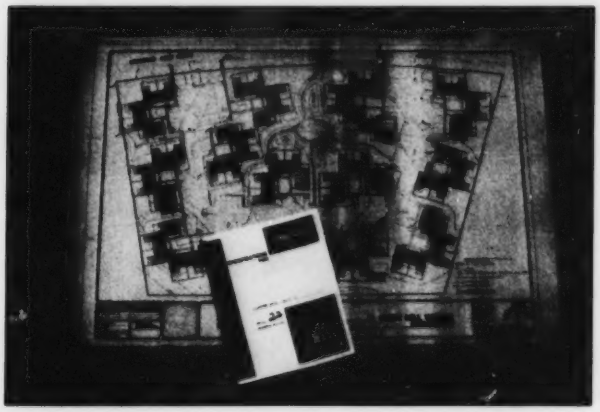


Fig. 186 A set of landscape plans and the accompanying specifications.

Typical plans and specifications that may be included as part of the tender documents include:

- site analysis (existing features, such as buildings, easements and vegetation)
- layout plan (locations and dimensions for hard and soft landscape elements; this also serves as a key reference plan for construction details)
- grading plan (using contour lines and spot elevations, illustrates all vertical changes and elevations)
- planting plan (indicates layout of all planting with types, sizes and conditions found in a plant list)
- irrigation plan (layout of irrigation system, including locations of sprinkler heads, piping and valves)
- lighting plan (illustrates lighting layout, types, sizes and intensities; may also include wiring layout and conduit locations)
- construction details (layouts in plan, elevation or section for each item that requires detailing for construction purposes; drawn details should clearly illustrate materials to be used, dimensions, installation procedures, and should be referenced to specific locations on the layout plan)
- landscape specifications (technical specifications, usually written, on-site work, grading, topsoil, planting, soil tests and construction techniques for all aspects of hard and plant materials)
- maintenance program (optional but a valuable addition to contract documents to ensure that adequate maintenance is done at required times, and that the maintenance budget is satisfactory).

6.3 CONSTRUCTION SUPERVISION

The amount of supervision necessary during the implementation of a landscape project depends upon the complexity of the design and the contractor's knowledge and experience. If a number of contractors are involved on the same site, a degree of coordination should be maintained.

Often, the landscape architect or site supervisor is not required for full-time supervision, but is needed to perform periodic inspections at critical stages of the work. He or she may also be needed to ensure that work is completed on schedule, to verify the quantities and quality of installed materials, to issue and process progress claims, and to approve any changes on behalf of the client. The last visit to the site is usually for a meeting between the owner, the construction supervisor and the contractor in order to accept the completed project. If the work has been done according to the contract documents and all three parties are satisfied with it, a final inspection report is written by the construction supervisor and the contractor can then be paid the balance of his earnings.

It is recommended that site inspections be done at regular and/or at key times during construction. The following are some of those times:

BEGINNING OF PROJECT. It is advisable for both the designer and the contractor to go over the limits of the contract and generally organize themselves for the start of the project. This session may also serve as an introductory inspection of the workforce and equipment to be used on the site.

STRIPPING OF TOPSOIL, STOCKPILING AND ROUGH GRADING. During the stripping of topsoil, it is important that an excess of clay and other foreign matter does not become mixed with the topsoil. Perhaps soil tests should be taken to determine the soil characteristics. A place should be chosen to stockpile the topsoil and a periodic inspection of rough grading operations may help prevent future settlement, erosion or drainage problems.

PROTECTION OF EXISTING VEGETATION. Any existing vegetation that is to be incorporated into the final design should be protected from construction equipment by snow fences or other barriers. Appropriate procedures and locations must be determined so that the work can proceed efficiently with a minimum of damage to plants.

Fig. 187 Construction supervision by qualified personnel helps prevent damage to existing vegetation during grading operations.

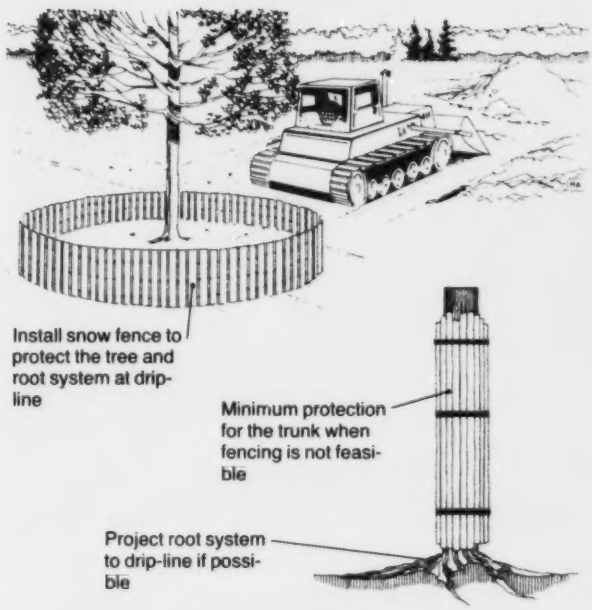

Install snow fence to protect the tree and root system at drip-line
Minimum protection for the trunk when fencing is not feasible
Project root system to drip-line if possible

Fig. 188 Methods of protecting trees during construction.

LAYOUT AND STAKING OF LANDSCAPE FEATURES. After the site has been prepared for construction, the physical layout of the landscape design is done on-site from the contract documents. Usually stakes are installed at edges, corners, centrelines or radii of hard materials, and at proposed tree and shrub locations, to indicate the locations and limits of landscape features. Staking is often done by the designer and the landscape contractor, so that each party agrees upon the intent of the site layout. Staking may also be done directly by the landscape contractor and then inspected by the designer before construction begins. It is important that the staking be done accurately and according to plan; any changes to the landscape design always must be approved first by the designer.

INSTALLATION OF HARD MATERIALS. The installation of hard materials,such as sidewalks, fences and retaining walls, should be carefully supervised. Hard materials cannot be moved or altered as easily and inexpensively as plant materials.

Fig. 189 It is often advantageous to supervise critical stages of site construction, such as adding retaining walls and fences, so that the work is done accurately, safely and according to the contract documents.

PLACEMENT OF TOPSOIL AND FINISHED GRADING. It is important to ensure that topsoil is placed at the specified depths and that finished grading is accurate and conforms to the grading plan. It is advisable to inspect the finished topsoil surface before seeding or sodding begins. Drainage is a prime concern on a site, especially around buildings and near drainage basins.

TIME OF PLANTING, SEEDING OR SODDING. A landscape architect should oversee tree and shrub planting, and should evaluate the plant material, preferably before it arrives at the site. Plants should be checked for insects and diseases. Staking and adding guy wires must be done according to specifications. Grass seed and sod should be inspected before installation, and should meet the grade and quality called for in the specifications.

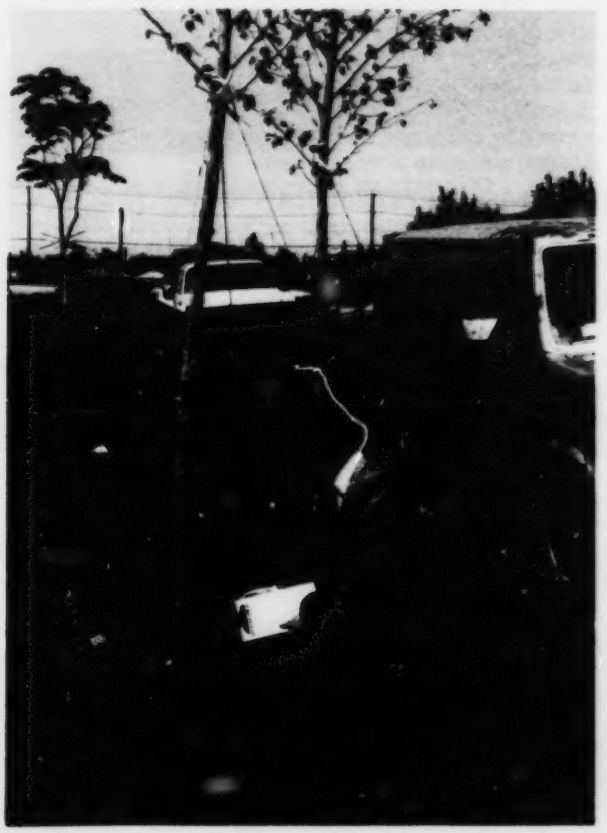


Fig. 190 A landscape architect inspecting the caliper of recently planted trees.

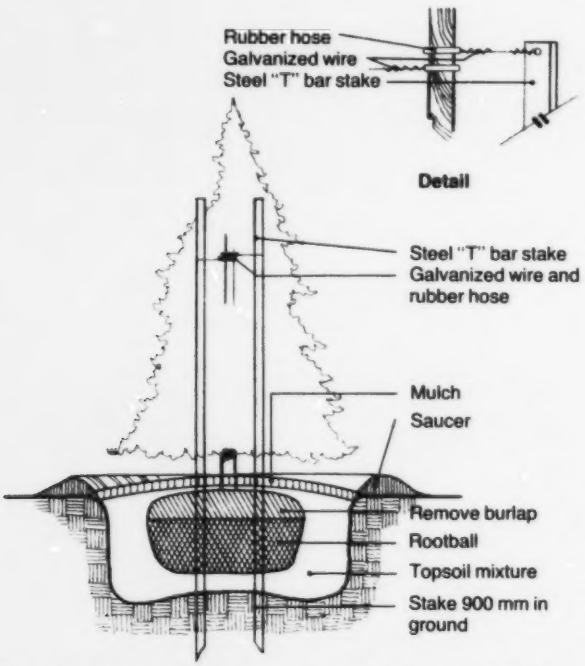


Fig. 191 Planting method for coniferous trees under 2 m high.

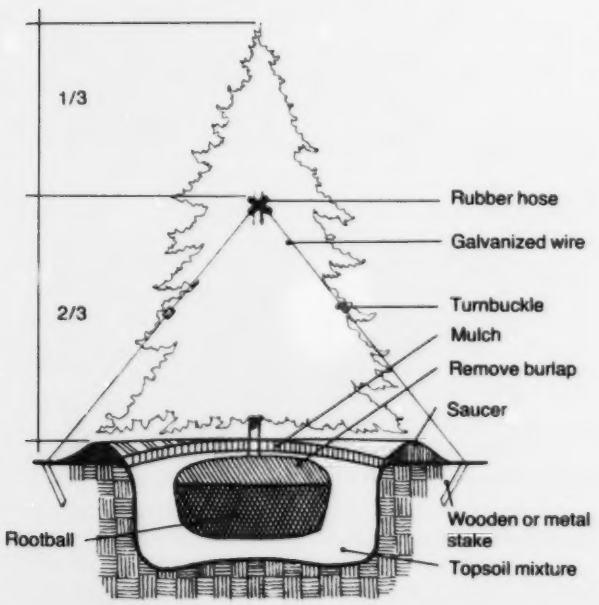


Fig. 192 Planting method for coniferous trees 2 m and higher.

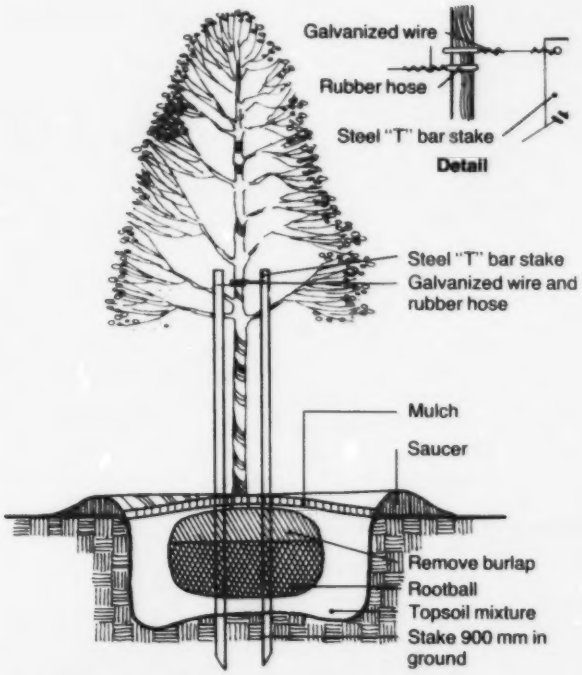


Fig. 193 Planting method for deciduous tree up to 65 mm caliper.

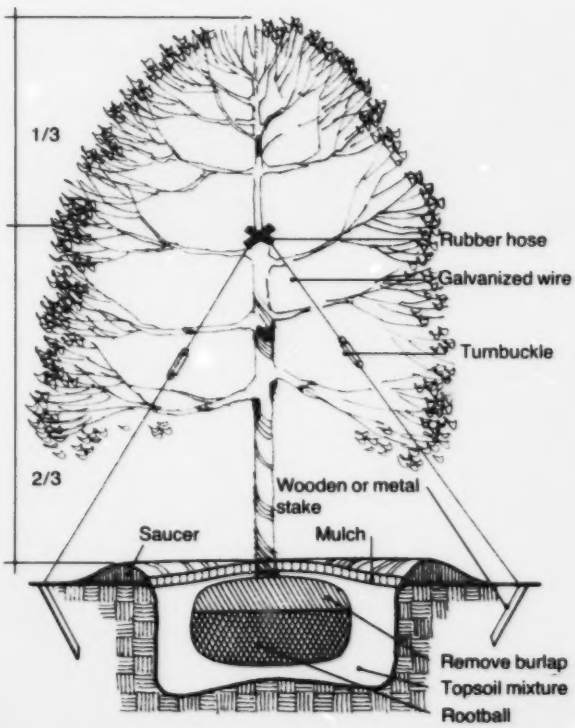


Fig. 194 Planting method for deciduous tree over 65 mm caliper.

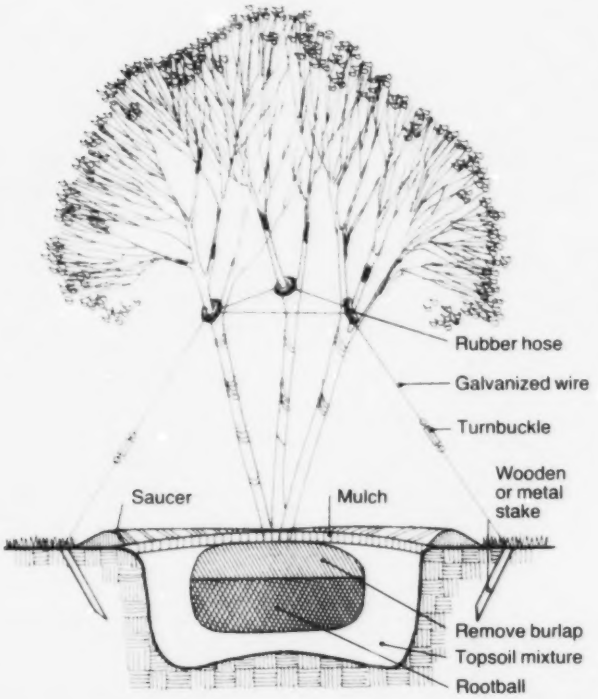


Fig. 195 Planting method for tree clump.

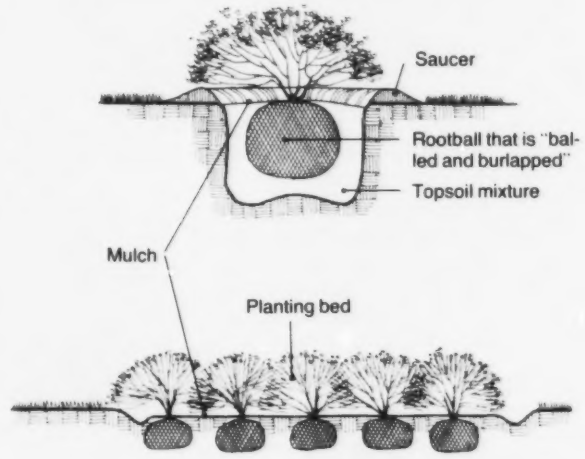
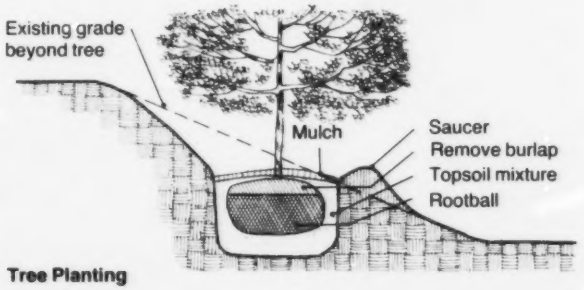


Fig. 196 Planting method for deciduous shrubs that are bare root or bound in burlap.



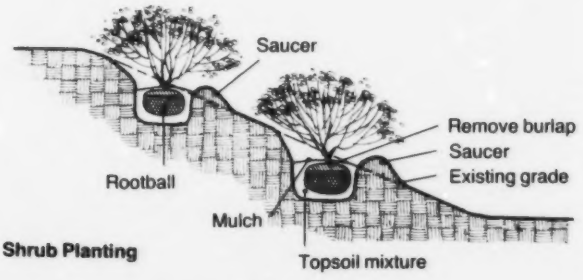


Fig. 197 Planting on a steep slope.

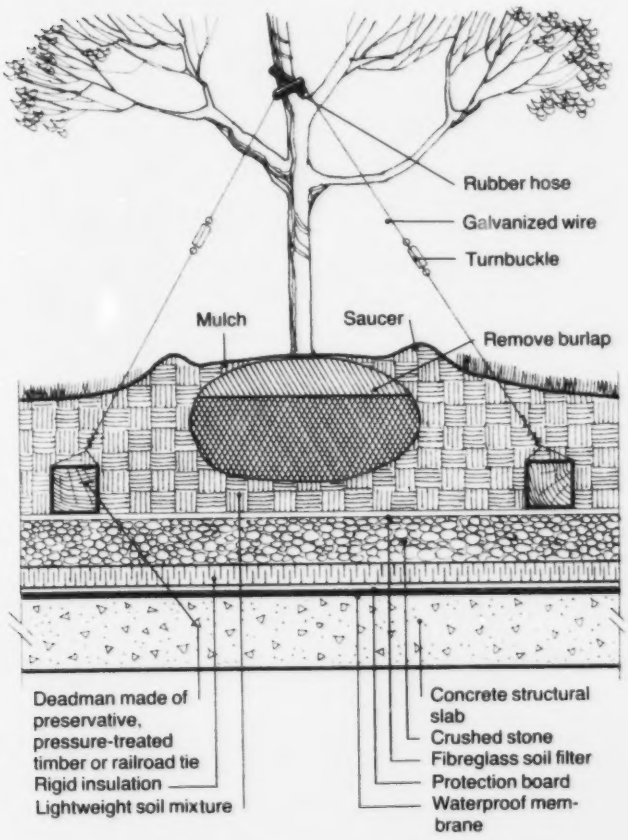


Fig. 198 Method of planting a deciduous tree of over 65 mm on a roof deck.

PROJECT COMPLETION. After all landscape features have been installed, a final inspection of the project is necessary, for official approval. This should ensure that the hard landscape features are constructed as specified, plant material is healthy and well secured, and the site is in a clean and acceptable condition. This inspection should be followed by a detailed inspection report and project summary, indicating all change orders, addenda and progress claim forms to date. A release of the contractor's security bond(s) may be applied for after final acceptance is granted.

INSPECTIONS OF REGULAR MAINTENANCE. If the contractor is responsible for a period of maintenance after the project has been completed, it may be advantageous periodically to inspect the maintenance procedures to ensure that the work is being carried out regularly and properly. It may be desirable to have a formal maintenance program developed to reduce replacement costs and maintain the project's visual character.

6.4 MAINTENANCE PROGRAMS AND BUDGETS

Landscape maintenance refers to the general upkeep of exterior site spaces, including both hard and plant materials. The initial maintenance program on a site is the contractor's responsibility. A maintenance agreement for the period of construction and after is usually included in the tender documents as part of the landscape contract. It continues usually for four to six weeks after the project is finished and includes a one-year replacement guarantee for plant material. After this period, maintenance becomes the owner's responsibility.

Good maintenance practice is important to develop and maintain the image of a particular development, as well as to protect the initial property investment. Property managers and others claim that damage caused by vandalism and neglect occurs more frequently in poorly maintained areas. It is important, therefore, to provide an adequate budget to establish and maintain a comprehensive maintenance program.

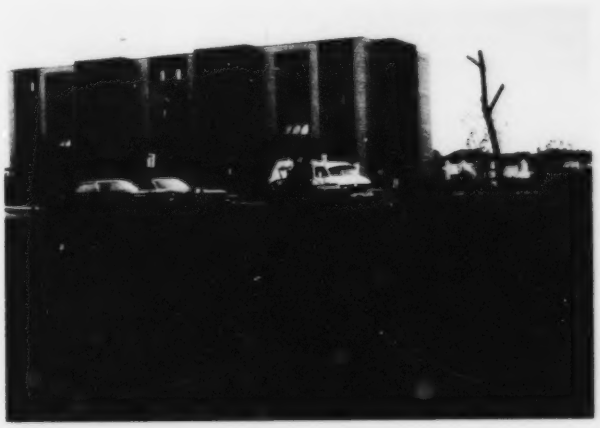


Fig. 199 A better maintenance program would improve the appearance of this housing development.

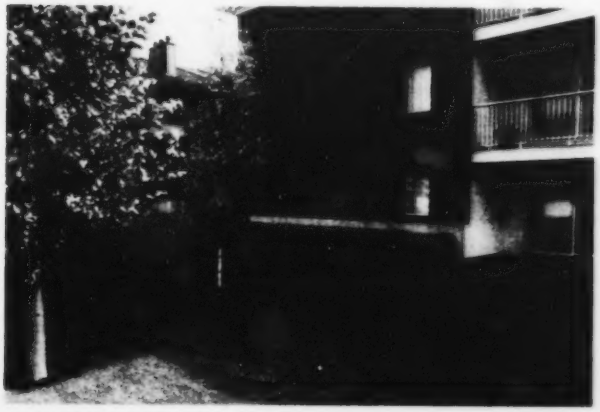


Fig. 200 Good maintenance procedures enhance the site and generally improve the quality of housing.

The amount of maintenance needed will vary, depending on how frequently a given area is used and the types of hard material upkeep and plant treatments adopted. Maintenance levels should be consistent with the design intent. Highly manicured areas, with lawns and intricate shrub beds, will require a greater level of maintenance than natural landscapes that include rough grasses and native plants.

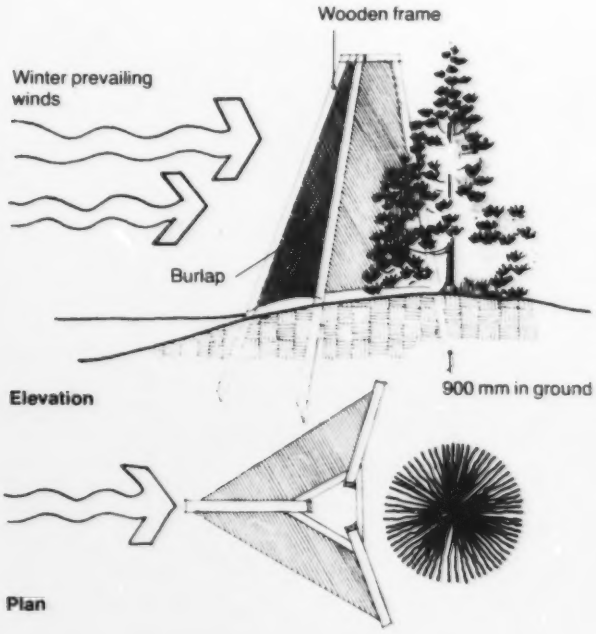


Fig. 201 Winter screening against predominant winds for coniferous trees.

At the design stage, it is important not only to determine capital site development budgets, but also the budgets and manpower that will be required to facilitate continuing annual maintenance. A pre-determined maintenance budget by the developer will affect the designer's selection of materials, the complexity of design and the capital development costs.

The development of a landscape design that would not require any maintenance is an unrealistic objective; however, creating a landscape that requires little maintenance is a laudable goal. Unless there is a realistic expectation of the budget and staff that will be required to maintain a project, the landscape design should ensure that little maintenance is necessary.

Fig. 202 The use of interlocking pavers on this median, instead of grass, reduces maintenance; however, weeds growing between the pavers should be removed. Grouping the plants would have been more attractive and would have increased their chances of survival.

Fig. 203 Grass and other vegetation does not often survive below balconies and other overhangs near grade, because the area does not receive enough moisture and light; refer to Figure 204.

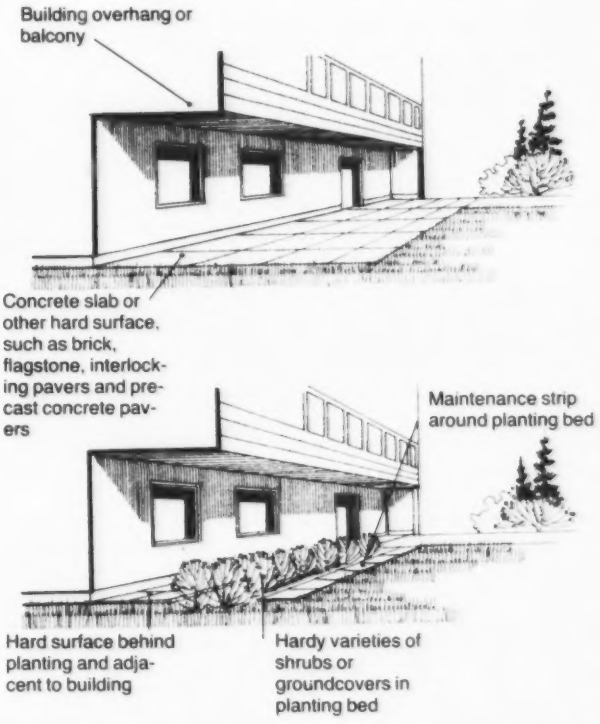

Building overhang or balcony
Concrete slab or other hard surface, such as brick, flagstone, interlocking pavers and precast concrete pavers
Maintenance strip around planting bed
Hard surface behind planting and adjacent to building
Hardy varieties of shrubs or groundcovers in planting bed

Fig. 204 Possible solutions for maintenance problems below building overhangs and balconies.

Fig. 205 Typical low maintenance applications.

Item	Low Maintenance Application	Result
Trees	Use of male tree (i.e., Ash) to avoid seed drop	• less clean-up and raking • less growth of unwanted seedlings
	Adequate tree spacing in lawn areas	• better undergrowth development • allows use of gang-mowers between trees
	Mass tree planting in beds with mulch or groundwater below	• good visual effect • no mowing necessary between trees, just around beds
	Upright support staking rather than guy wire from pegs	• ease of mowing around trees • less trimming required • fewer hazards to pedestrians
	Locate trees away from edges of curbs and walks (distance depends on type, size and root habits of tree; generally, 2 metres minimum)	• less cracking and break-up of paving surfaces from root spreading • ease of pedestrian or vehicular movement without lower branches interfering
	Use of larger caliper trees (50 mm caliper minimum)	• more resistant to trampling and vandalism
Shrubs	Massed shrub planting in large beds rather than scattered shrub planting	• ease of watering, cultivating and mowing • less susceptible to trampling and vandalism
	Use of mulch in planting beds	• reduce weed growth • reduce wind erosion • preserve soil moisture
	Use of edging or maintenance strips around shrub beds, buildings and site furniture	• ease of mowing and clean-up of adjacent areas • acts as a barrier to grass and weed infiltration
	Use of hardy varieties of shrubs	• less prone to die in the winter • require less care to survive
	In drier areas, underground irrigation system for shrub beds and grass areas	• less time required for frequent waterings • allows landscape maintenance personnel to do other tasks • ensures plants have necessary amount of water.

Fig. 206 An area on the north side of a building which has been treated with a layer of crushed stone, contained by wood edgers to reduce maintenance.

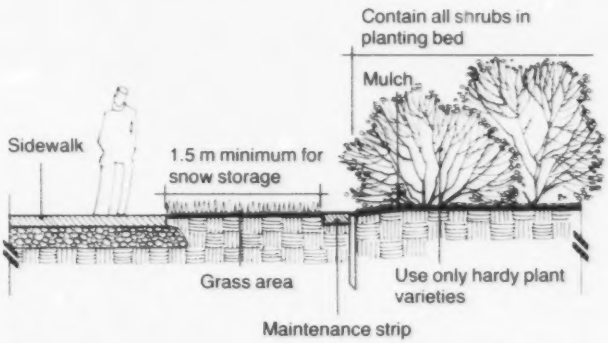


Fig. 207 Low maintenance applications for planting beds.

Fig. 208 Examples of times and costs related to completion of typical landscape maintenance operation.

Landscape Maintenance Operations		
Operation (1)	**Approximate Time Required (In Minutes) (2)**	**Estimated Cost (Dollars) (3)**
Turf Mowing (and catch clippings)		
Small area (100 square metres) with hand-manoeuvred 500 mm mower	15	5.00
Large area (5 000 square metres) with rider-operated 1 500 mm rotary mower	35	10.00
Fertilizing		
Small area (100 square metres) with rotary spreader	5	20.00
Large area (5 000 square metres) with rotary spreader	45	200.00
Spraying		
Small area (100 square metres) with a tank carried on the back	10	30.00
Large area (5 000 square metres) with a 1 500 litre tank and two operators	90	250.00
Edging (30 metres)		
By hand	45	15.00
By mechanical edger		
• curbs	15	10.00
• other edges	20	15.00
Trees		
Spraying small trees (50-75 mm caliper)	10	5.00
Large trees (150-300 mm caliper)	25	12.00
Pruning (heavy)		
Small trees (50-75 mm caliper)	10	4.00
Large trees (150-200 mm caliper)	35	25.00
Watering (20 trees; with water truck)	60	35.00
Shrubs		
Spraying		
Small shrubs (1 metre ht.)	2	0.75
Large shrubs (2 metre ht.)	4	1.50
Pruning		
Small shrubs (1 metre ht.)	5	1.50
Large shrubs (2 metre ht.)	15	5.00
Watering (9120 shrubs; with water truck)	60	35.00
Groundcover		
Spraying		
Large area (100 square metres)	15	35.00

(1) Includes labour, equipment and materials
(2) Does not include time for travel, set-up and clean-up
(3) Costs for Alberta, 1981

It is helpful to estimate the maintenance costs as soon as possible so that the materials chosen by the landscape designer can be assessed for their long-term usefulness. Landscape maintenance budgets are often inadequate.

A maintenance schedule is a guide for executing proper maintenance procedures at the correct time. A detailed schedule will permit maintenance staff to accomplish more by allowing them to use their equipment and supplies efficiently, and to carry out necessary maintenance operations when it is most beneficial to do so. Another important reason for developing an accurate maintenance schedule is so that a sound maintenance budget can be developed to help project owners and property managers establish priorities.

Plants in the Landscape by P.L. Carpenter, T.D. Walker and F.O. Lanphear (W.H. Freeman Co., 1975) recommends that the first step in developing a maintenance schedule is to classify the different areas of the landscape site according to the degree of maintenance each will need. A simple classification system divides areas into high, medium or low maintenance. High maintenance areas usually contain carefully manicured turf, shrubs, groundcover, flower-beds and well-cared-for-trees. Such areas are often found near the entry to a development and therefore must be well maintained.

Medium maintenance areas are found in the majority of the public spaces and all the communal areas of a development, where mowing, weeding, pruning and fertilizing are carried out routinely. Snow removal would also be classified in this section.

Low maintenance areas are primarily found in natural areas and specially designed portions of the site development. Maintenance will generally consist of trash pick-up, and upkeep of roads, parking lots and sidewalks. Hard-surface paving materials, such as asphalt and concrete, in difficult-to-maintain areas may need to be cleaned and swept periodically but should not require as high a degree of maintenance as if they were grassed or planted with annual flowers.

In cases where the project is large enough to warrant maintenance staff or a maintenance contractor, periodic site inspections by qualified personnel can remedy poor technical practices and suggest ways to save money. One solution is to have a competent property manager on staff, familiar with landscape maintenance procedures, and then hire a landscape maintenance contractor by tasks or seasons, whichever is the more efficient. Once the extent of maintenance operations has been determined, it is possible to develop the maintenance schedule, an example of which is included in Appendix C. (Appendix D is a typical landscape maintenance specification.)

It is advisable to develop the maintenance schedule before setting a budget so that it will complement the degree and quality of maintenance required. Unfortunately, many maintenance budgets are determined before the schedule is developed, which leads to a slow depreciation of the site because the cost of maintenance was not fully recognized. To avoid this, the budget should be developed by a team, comprising the owner, landscape architect, maintenance supervisor, property manager and anyone else directly involved in the site development. Together they should evaluate all aspects of the landscape design and calculate costs for material type, size or area, based on maintenance procedures. It will then be possible to arrive at a total maintenance budget that can be broken down into an estimated cost per unit per month.

Fig. 209 A typical landscape maintenance budget for a 66-unit condominium project, Edmonton, 1979. Source: Castille Realty Services Co. Ltd., Edmonton.

Item	Project Cost
1. Landscape Maintenance (Plants)	
Assumes each owner is responsible for their individual yard area (exclusive use area)	
a) Spring clean-up	$ 700.00
b) Lawns, trees & shrubs $725.00 per month for five months (May through September)	$ 3,625.00
c) Provision for tree replacements and upgrading	$ 2,000.00
2. Maintenance and Repairs (Hard Materials)	
a) Parking lots	$ 1,000.00
b) Exterior of buildings and fences	$ 1,000.00
c) Signage — general maintenance and replacement	$ 100.00
3. Snow Removal	
a) Sidewalk — 20 cleanings at $125.00/cleaning	$ 2,500.00
b) Parking lots — 4 cleanings at $250.00/cleaning	$ 1,000.00
Item	**Project Cost**
4. Miscellaneous Expenses	$ 500.00
5. Subtotal*	$12,425.00
6. Cost Per Unit Per Month*	$ 15.69

*Does not include costs of administration, insurance and other miscellaneous expenses

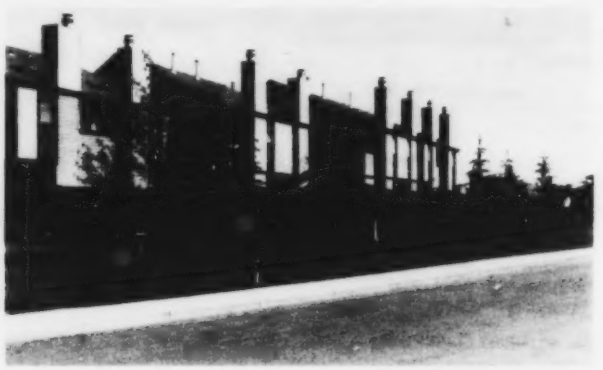


Fig. 210 Site maintenance level of the condominium project referred to in Figure 209.

6.5 MAINTENANCE PROCEDURES

Maintenance procedures are necessary for plant and lawn growth as well as for hard landscape materials. All maintenance operations should be listed in the schedule so that the procedures can be executed at the correct time and in the proper manner. The maintenance procedures outlined in this section are organized into two main categories: plant materials and hard materials. The plant category includes lawns and is concerned with fertilizers, weed control, insect control, mowing, watering, pruning and vandalism.

Fertilizer should be applied to lawns twice a year — in early spring and in the fall. A balanced turf fertilizer, either a non-burning chemical or organic type with a well-balanced nitrogen (N), phosphorus (P), potassium (K) analysis such as 10-6-4, 14-4-8, 7-7-7 or 18-6-9, should be applied at the rate recommended by the manufacturer, or as determined by soil tests. Both organic and inorganic fertilizers are suitable, but the latter can be safely used only when directly incorporated into the topsoil or after a heavy watering. Organic fertilizers release nitrogen more slowly, so there is less chance of burning. They may be applied directly to existing turf areas.

Fertilization of trees and shrubs should be done only in the early spring, using the same fertilizers listed above. For shrub beds and open areas around shrubs, fertilizer should always be worked into the soil to a depth of 30 mm. For individual trees planted on lawns, fertilizing is best done with an injection needle, a hollow steel tube attached to a water supply. The fertilizer is placed in the tube in a cartridge form and dissolves as the water passes over it. The needle should be pushed to a depth of 300 mm at approximately 300-400 mm intervals, from the drip-line to the trunk of the tree.

Adjusting the soil pH may be necessary if it is extremely acidic or alkaline. Most plants prefer an almost neutral soil, with a pH of 6.0 to 7.5. To increase the soil pH, limestone should be well worked into the soil; to reduce the pH value, aluminum sulphate, powdered sulphur or peat moss should be mixed into the soil to make it more acidic.

Weeding around shrubs and trees in planting beds should be done by hand because hoes and rakes may damage delicate feeding roots near the surface. Mulches are commonly used as an effective method of weed prevention.

Fig. 211 Tools and other maintenance equipment ideally should be stored within easy reach.

There are many herbicides on the market that kill broad-leaved weeds such as dandelions and plantains. The most common contains a large proportion of 2,4-D; with the addition of dicamba and mecoprop, it controls chickweed and clover. Remember that this chemical is also capable of damaging and killing trees, shrubs and flowers, and must be applied in strict accordance with the manufacturer's instructions.

Many insects and other organisms are harmful to plant life. They can easily be detected by closely examining the foliage and branches. Pesticides must also be applied in strict accordance with all federal, provincial, and local government regulations. Consult a knowledgeable authority, such as the local office of Agriculture Canada, whenever advice on insecticides is required. One of the most commonly used insecticides for the control of leaf- sucking insects, such as aphids and leaf miners, is Malathion. It should be sprayed onto the foliage of the plant, usually in one or two applicatons, approximately three or four weeks apart. Other useful insecticides available are Diazinon, for the control of sod webworm in lawns, dimethoate, for the control of birch leaf miners, and Carbaryl, to control various types of caterpillars, including tent caterpillars.

Mowing is one of the most necessary forms of turf care. It should be done weekly if required, to a height of not less than 35 mm during the growing season. The grass should not be allowed to grow any higher than 75 mm. This will help to promote dense growth and avoid the need to remove large quantities of clippings. Grass is best cut when it is completely dry.

Frequently watered plants are relatively easy to manage. Watering trees and shrubs should be done regularly until they are well established, especially in dry weather. Evergreen shrubs and trees should be given a thorough soaking in the fall before the ground becomes frozen; this provides instantly available moisture in the early spring.

Excessive irrigation of lawns may encourage the development of weaker turf grass plants which are more susceptible to disease and trampling and less tolerant to heat, cold and drought stress. However, a lack of moisture will retard the growth of the desirable grass types, such as Kentucky bluegrass and fescues, and a takeover by weed grasses and quackgrass is a common problem. An optimum irrigation level is where the frequency of watering, occasional deep soaking instead of frequent light watering, will benefit the lawn by encouraging the growth of desirable grasses in order to produce thick and healthy turf.

Pruning trees and shrubs keeps them healthy. Other objectives of pruning are to:

- remove dead or diseased wood
- alter form, such as topiary
- produce a well-balanced plant that allows sufficient light and air into the centre, thus inducing growth of healthy wood, flowers and fruit
- rejuvenate old plants
- guide new growth around obstructions; such as pruning large trees to prevent them from interfering with overhead wires and building overhangs
- encourage root development.

Proper pruning at the time of planting will normally help trees and shrubs survive the disruption and injuries incurred when they are brought from the nursery to the site. The first pruning usually removes broken and damaged top growth in order to balance it with root system development.

Fig. 212 Pruning should be done by an experienced landscape contractor, nurseryman or horticulturalist.

Pruning should generally be done in the late winter or early spring. Rejuvenation pruning should be done in the spring because a severe reduction of branches later in the season seems to have a weakening effect, and the plant takes longer to recover. Flowering shrubs should be pruned immediately after flowering; this induces young, healthy growth and encourages full blooming the following season. Pruning young wood in the fall or spring reduces future flowering. Pruned cuts over 25 mm in diameter should be covered with a decay preventative compound that encourages the forming of new bark. Wound dressings may have to be applied more than once if large cuts have been made.

Some trees and shrubs will require special, or more frequent, attention than others. In such situations it is advisable to consult a trained horticulturalist, nurseryman or landscape contractor who is experienced in proper pruning methods and wound treatments.

Plants damaged by storms, accidents or vandalism should be treated immediately to prevent permanent damage. Broken branches should be cleaned and cut smooth with a sharp knife or saw and dressed with a light application of an approved wound dressing or tree paint. If the damage is severe, consult a tree surgeon. Staking and guying lines should be checked regularly; damaged lines or broken stakes should be replaced. Guy wires should be removed when the plant is rooted and well established.

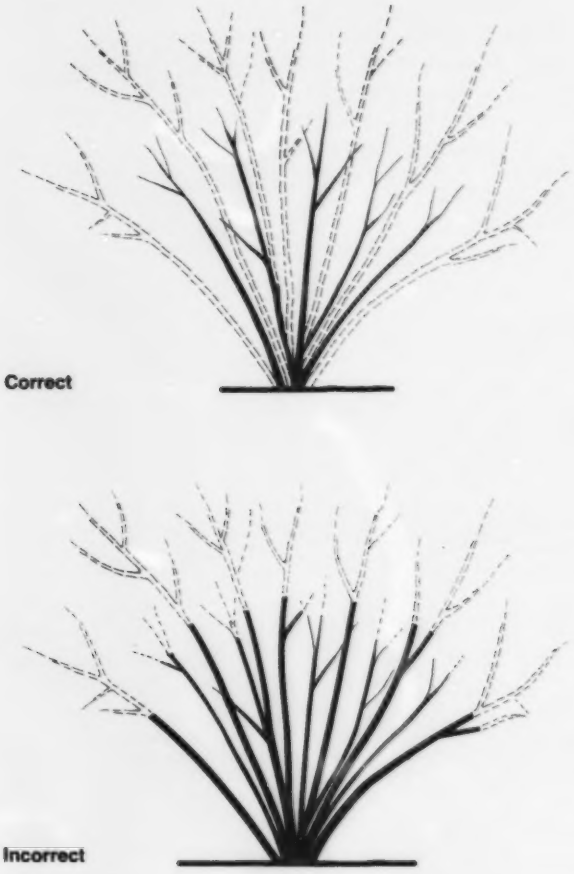


Fig. 213 Examples of how to prune a young shrub; the dashed lines represent the branches and twigs that have been removed.

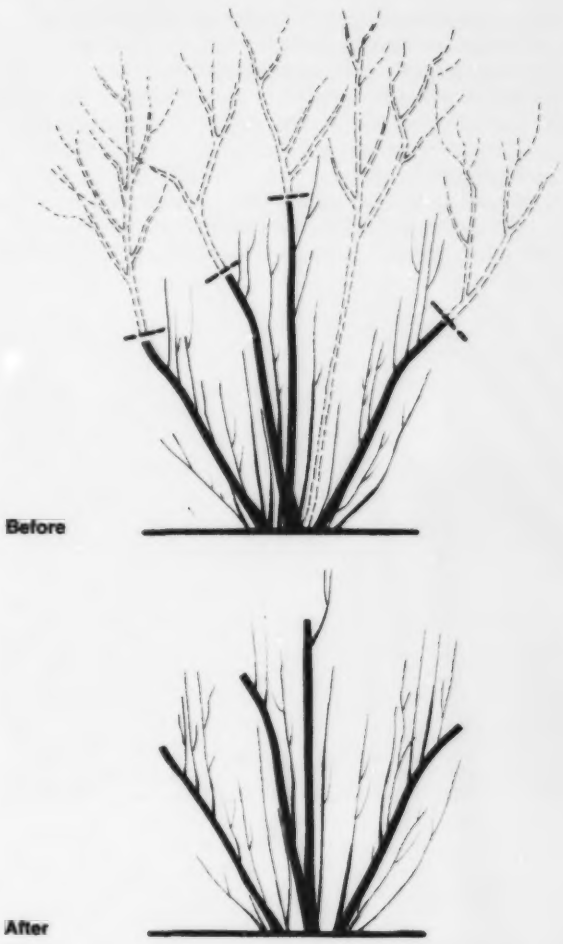


Fig. 214 How to prune a mature and overgrown shrub; the dashed lines represent the branches that have been removed.

Turf damaged by excessive wear or inadequate maintenance may need to be replaced. This can be time-consuming and costly, so it may be better to determine the cause of the problem and treat it accordingly. For example, a well-worn path in a lawn may indicate the need for a more permanent material, such as concrete or asphalt. Otherwise, barriers like planting or fences may be necessary to discourage pedestrians from taking that route.

The second category of maintenance procedures is hard materials — paving surfaces, fences, site furniture and lighting. Asphalt is the most common paving surface for roads and walks but it often shows signs of excessive wear or poor installation. For example, "alligator cracks" (jagged cracks occurring in the paving surface) may be caused by poor subgrade preparation; if this is so, the entire area may have to be removed down to undisturbed subsoil, replaced with crushed stone and then firmly compacted before the new asphalt surface can be laid.

Fig. 215 This pavement failed because of an insufficient sub-base; replacement and compaction of sub-base and surfacing materials is necessary.

Reflection cracks are often caused by expansion and contraction of the base layers in response to changes in temperature and moisture content (i.e., freeze-thaw action). These cracks should be filled with an asphalt emulsion crackfiller to prevent further deterioration. A rough and worn asphalt surface may be caused by excessive use. Resurfacing would be required to maintain a smooth surface condition after application to the old surface of a suitable tack coat (slow-setting asphalt emulsion used to increase bonding).

Concrete surfaces normally require little more than normal cleaning and brushing. Cracking may occur if too few expansion joints were put in when the concrete was installed. Repairs to cracked concrete are best done with tar or an asphalt emulsion, rather than concrete. This will absorb the expansion and contraction which takes place during temperature fluctuations. Where the surface has disintegrated, the best method of repair is to remove and replace the old concrete. Any resurfacing with new concrete must be at least 50 mm thick, or further flaking will occur at the first frost.

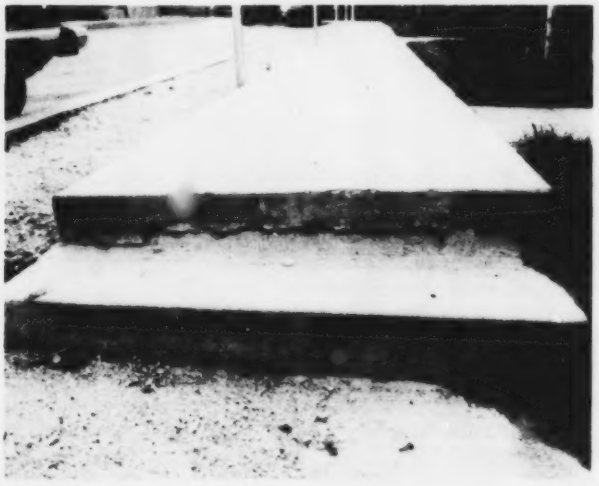


Fig. 216 A failure of the subgrade has caused these steps to crack badly. The best method of repair would be to remove them, stabilize the subgrade, add compacted crushed stone and replace the steps with new concrete.

Interlocking pavers, flagstone and similar paving may need to be replaced if cracking or settlement occurs. Damage to pavers is most often caused during snow removal; power machinery with snow blades may chip and crack stones that have been set irregularly. Failure of edge blocks is also a common problem because of inadequate edging and poor sub-base compaction.

The replacement of a unit paver is quite simple if mortar has not been used. The damaged block is simply replaced with a new one and sand is then brushed back in between the blocks.

If the pavers are set on a solid concrete base with mortar, it may be necessary to break up a small portion of the surface and replace it from the base up. This is time-consuming and expensive.

Fig. 217 Shifting of edge blocks is a common problem with interlocking pavers, which are not contained by edgers.

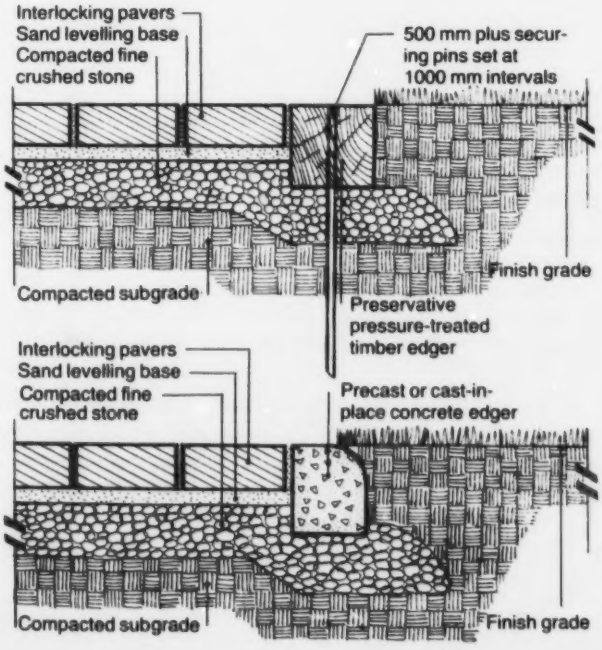


Fig. 218 Proper methods of edging interlocking pavers.

Gravel, shale and stonedust may have to be maintained frequently, especially to remove weeds. Spraying, hoeing and raking keeps these materials at an acceptable standard. Annual "topping" (placing new material on top of the old) helps drainage and keeps the pavers attractive.

Gravel spreading onto adjacent areas is another problem with this type of unstable surface. If stones and shale are spread onto lawns, the surface must be compacted to reduce further maintenance.

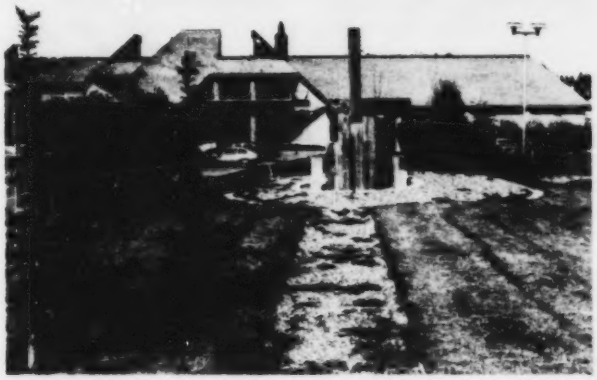


Fig. 219 Weeds and grass growing up through gravel paths is a common problem; gravel paths should be avoided because they are hard to walk on and difficult to keep up.

Wood decking and other types of wood surfaces should be pressure- treated or treated with a least two coats of wood preservative to prevent rotting, especially where the wood is in direct contact with soil or water. Wood decking may occasionally require upgrading — replacing broken or damaged pieces of deck for safety's sake. Removing snow from wood is generally more difficult than from concrete or asphalt because of the uneven surface and the spaces left between the boards for drainage. Snow removal with shovels or scrapers should be done carefully so as not to damage the wood. It is better to use soft brooms on wood surfaces to prevent splitting and splintering.

Fences should be checked annually for needed repairs, such as replacement of latches, hinges and locks on gates, as well as the customary painting and staining. Galvanized or zinc-coated fence hardware means less maintenance because these coatings inhibit rust and outlast conventional hardware. Wood fences generally require substantial maintenance because their neat and orderly appearance is a direct reflection of a project's character. Metal fences require practically no maintenance if they are properly installed.

Movable site furniture, such as benches and planters, should be stored indoors during the winter. Painting, staining and general maintenance may be done at this time. It should be possible to remove furniture from its base in case replacement parts or major repairs are necessary.

Site lighting must be checked regularly: bulbs have to be replaced and it is important to see if vandalism has occurred. If site lighting is not vandal-resistant, bulbs are stolen and fixtures are broken. Lighting maintenance should be a high priority since safety and proper surveillance depend on it.

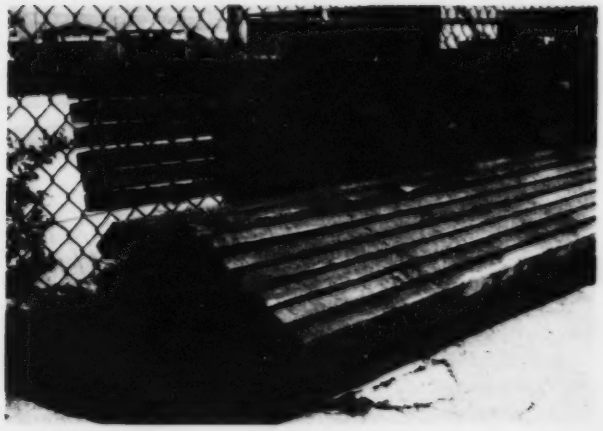


Fig. 220 Benches should be of sufficient strength and durability to withstand damage.

6.6 SUMMARY CHECKLIST

Have appropriate measures been taken to reduce erosion and sedimentation before, during and after site construction, such as avoiding the creation of steep slopes, exposing bare soil for the shortest possible time, reducing run-off velocity and quantity, and retaining existing vegetation? (Refer to Section 6.1)

Is the site construction contract being issued on a lump sum or unit price basis, or on a labour and materials cost-plus basis? (Refer to Section 6.2)

Have the proper tender documents been included in the landscape contract, such as bid documents, contract forms, contract conditions, technical specifications and working drawings? (Refer to Section 6.2)

Have the following construction drawings and specifications been included as part of the landscape contract: the site analysis plan, layout plan, grading plan, planting plan, irrigation plan, lighting plan, construction details and landscape specifications? (Refer to Section 6.2)

Does the contract stipulate that site inspections should take place during the construction schedule and that detailed site inspection reports are required? Are inspections done at the beginning of the project, check on: stripping of topsoil and rough grading, protection of existing vegetation, layout and staking of landscape design on-site, installation of hard materials, placement of topsoil and finish grading, time of planting and sodding, project completion and inspection of regular maintenance? (Refer to Section 6.3)

Have ways been considered of providing a landscape that requires little maintenance? (Refer to Section 6.4)

Has a comprehensive maintenance schedule been developed to act as a guide to maintenance operations and times? (Refer to Section 6.4)

Has the maintenance budget been developed in conjunction with the maintenance schedule, and is it sufficient to maintain adequately both hard and plant materials? (Refer to Section 6.4)

Are maintenance procedures for trees, shrubs, groundcovers and lawns understood and followed according to the maintenance schedule, including fertilizaton, weed control, insect control, mowing, watering, pruning and repair of damage to plant material? (Refer to Section 6.5)

Are hard materials being sufficiently maintained, particularly the upkeep and repair of paving surfaces, fences and walls, site furniture and site lighting? (Refer to Section 6.5)

APPENDICES

A. Glossary of Site Terms
B. Climatic Data
C. Typical Maintenance Schedule
D. Typical Landscape Maintenance Specification
E. References

APPENDIX A: GLOSSARY OF SITE TERMS

Acid soil Typically found in a coniferous forest, this soil has a pH value below 6.6: based on a 1 to 14 rating of acid to alkaline, with 7.0 being neutral.

Aeration Mixing air with the soil to make it easier for plants to grow in it.

Alkaline soil A soil with a pH value of more than 7.3, found in many arid regions. It is usually poorly drained.

Balled and burlapped A term applied to plants which have been dug from the nursery with a solid ball of earth around their roots. This is then wrapped and tied in burlap.

Bare root Plants which are set in the earth with their roots bare and unprotected by burlap.

Bedrock Solid rock, either exposed at the surface or below it.

Berm An earth embankment that is similar to a mound except that it is extended to become a linear landform; it is often combined with fencing or planting to create a visual or sound barrier.

Bollard A wooden, concrete or metal post used to prevent vehicles from entering a pedestrian area.

Boulevard strip The portion of a street right-of-way that lies between the curb and the property line; the term is also applied to a grassed or planted area between curb and sidewalk.

Broom finish A method of finishing concrete surfaces in which a stiff broom rubs the still wet surface, giving it a rough texture and linear pattern.

Caliper The diameter of a tree's trunk, normally measured at a height of 300 mm above grade.

Chain-link fence A fence of woven fabric, normally made of steel wire, attached to posts and rails.

Chamfer The removal of a corner or edge of a post, bench or landscape feature for increased comfort or safety.

Clay loam A soil containing from 20 to 50 per cent sand particles, 20 to 30 per cent clay particles, the remainder being silt particles.

Clay soil A soil containing more than 65 per cent clay particles.

Communal amenity area, communal space A recreation area within the boundary of a project, shared by the residents.

Conifer A resinous plant with cone-like fruits and needle-like or scaly leaves.

Contour, contour line An imaginary line that joins every point of a given altitude or elevation.

Contour interval The vertical distance represented by two consecutive contour lines; this interval is normally constant on a contour map.

Contract limit line A line establishing the legal limit of the area inside which construction work is to be carried out.

Crushed stone The angular particles left after stone has been mechanically crushed. Not to be confused with gravel, which occurs naturally and usually has rounded edges.

Cul-de-sac A short street or passageway open at one end only; a "dead end".

Culvert A pipe or channel to carry water under a roadway or other drainage obstruction.

Curb A low structure which defines and retains the edge of a roadway, walk, or other area.

Cut The volume of earth removed by excavation.

Deadman A piece of metal, concrete, or wood buried in the ground and used as an anchoring device.

Deck An elevated, unroofed platform attached to a dwelling. It is generally constructed of wood members, spaced to permit the passage of water between them.

Ditch A drainage channel, usually with a V-shaped profile, deeper than it is wide.

Drip-line A line projected on the ground which corresponds to the limit of a tree's foliage.

Dry-stone wall A stone wall laid without mortar; used as a low retaining wall.

Earthwork The moving of surface materials to create a change of landform during site construction.

Easement Part of a property that is legally accessible to a person or public authority other than the owner, for a right-of-way or the passage of services.

Edging A linear barrier between two surface materials; commonly used between a lawn and gravel.

Elevation The vertical distance between a given point and a reference point of known level (datum).

Erosion control The management of land to prevent erosion, which can be achieved by proper grading, maintaining vegetative cover, construction of drainage systems, terracing, or the use of retention ponds.

Evergreen Woody plants that retain their foliage throughout the year. Most conifers and some broad-leaved plants have this characteristic.

Fertilizer An artificial or natural substance added to the soil to provide one or more of the nutrients essential to the growth of plants; nitrogen, phosphorus and potassium are the main fertilizers.

Fill Soil or other material that has been added to the existing topographic relief of an area.

Finish grading The final surface adjustments made to a site after the buildings and other facilities have been put up; the term usually applies to manual placing and raking of topsoil.

Formwork The construction of forms for the placement of concrete walls and surfaces.

Gabion A structure made of wire mesh and normally filled with stone; sometimes used as a rough stabilization method along river banks.

Grading The process of changing ground levels and forms by moving earth materials.

Grading plan A working drawing showing the existing and proposed vertical dimensions of a site development, by means of contour lines and spot elevations at high and low points.

Grass A category of plants which represents about ten per cent of the world's flora. A grass leaf typically consists of a sheath and a blade. Common grass species include bentgrass, fescue, bluegrass and ryegrass.

Groundcover A mat of vegetation consisting of low, spreading or creeping plants.

Guy wire A wire attached to a stake, used to secure a newly planted tree against the wind.

Hardiness A term applied to a plant to determine the climatic extremes that it can survive.

Herbaceous Pertaining to non-woody plants which have the nature of a herb.

Hydroseeding The process of spraying a combination of fertilizer, grass seed, water and fibrous binder onto the prepared ground in the form of a slurry; often used on steep slopes and places that are hard to reach.

Indigenous A term applied to a plant or material which occurs naturally in a region, that is, without human intervention.

Infrastructure Public and private services, such as water, telephone, electricity and sewage disposal. Also called utilities.

Interlocking paving Precast concrete pavers of about brick-size dimensions, with shapes designed to interlock and provide mutual lateral support underneath.

Invert The level at the bottom of an underground drainage pipe; often at a manhole.

Irrigation The artificial distribution of water to promote plant growth.

Landscaping The general use of plant and man-made materials on a site, as opposed to landscape architectural design which is the integration of site layout and grading in addition to the materials.

Layout plan A plan which shows the exact locations and dimensions of proposed siteworks, buildings, roads and site features in relation to the existing site and structures.

Light standard Pole upon which an electric light fixture is mounted.

Lot line The line which bounds a plot of ground, legally described as a lot in the title of a property.

Maintenance The process of sustaining the level of physical quality of an existing building and site; usually involves a program of inspection, cleaning and repair.

Manhole A chamber built so that sewers, watermains or other underground service can be inspected and maintained.

Microclimate The localized climate of a given site, which is different from surrounding general climatic conditions because of topography, vegetation and orientation of the site to the sun.

Mound A small hill, usually round or oval in shape.

Mulch A layer of material, such as bark or wood chips, on the surface of the soil, which discourages weed growth and which leads to water loss through evaporation.

Outdoor living area An outside space immediately adjacent to and accessible from a dwelling, and capable of accommodating a variety of individual outdoor activities for the residents.

Patio A hard-surfaced area near a dwelling.

Plant material An all-encompassing term that refers to trees, shrubs, groundcovers, vines and grasses that may form part of a landscape design.

Play space An area furnished with play equipment or play-inducing features for children.

Play structure A structure on which children can climb, crawl, slide and swing.

Privacy space An area next to a dwelling and for the exclusive use of its residents; also an outdoor living area.

Property line A line, established by survey, which sets the legal boundaries of a property.

Pruning The selective removal of twigs and branches from plants.

Public space Publicly owned land to be used by the general public.

Railroad tie A large piece of lumber, generally 150 × 200 mm in cross-section; originally designed to support the rails of a railroad track but commonly used for general site construction.

Ramp A sloping surface which provides a pedestrian or vehicular connection between two levels.

Reinforcing bar A steel rod embedded in concrete in order to provide added strength; especially resistant to tension and loading stresses.

Retention pond A basin, pond or lake in which sudden influxes of surface run-off water is temporarily held before being released at a slower, controlled rate into the drainage system.

Roof deck An area on the roof of a building or other structure designed for residents' communal use.

Rough grading The initial modification of site levels, usually carried out with a bulldozer or other heavy equipment; applies normally to subsoil rather than topsoil.

Run-off The flow of excess surface water which passes over a site instead of entering the soil after precipitation.

Sandblasting The process of scouring a surface with a powerful sand jet for cleaning or adding surface texture.

Sandy loam A soil material containing 50 per cent to 80 per cent sand particles, less than 50 per cent silt particles and less than 20 per cent clay particles.

Settlement The sinking of an area after construction; often caused by inadequate soil compaction.

Shell landscape The minimum construction level for a site development; includes all site layout and grading needs and the functional hard and plant materials necessary to stabilize site areas and provide some aesthetic appeal.

Site development plan A detailed plan illustrating the proposed arrangement of a site, including site layout, grading, hard materials and plant materials.

Slope An inclined area that is measured as a ratio between vertical drop and horizontal distance. Also called gradient.

Sod A matting of grass and soil which is cut just below the roots and then used on a new site to provide quick grass cover.

Specification A written document which provides information on the quality of materials and workmanship required for a project. Specifications complement the working drawings.

Stonedust Residue from stone crushing; used for the finished surfacing of secondary walkways and as a levelling layer immediately below paving stones.

Subgrade The prepared and compacted ground level which is to receive a pavement or topsoil; the end product of "rough grading".

Surface drainage The removal of surface water from a site by natural run-off or a storm sewer system.

Topography The configuration of the surface of a site; its relief, forms and inclines.

Topsoil stripping Removal of the top layer of organic soil.

Trellis An open framework or lattice, used as a support for climbing plants.

Utilities Public and private services such as water, telephone, electricity and sewage disposal; also called infrastructure.

Water table The level below which the ground is saturated with water.

Weephole A drainage pipe in a retaining wall.

Wood preservative A chemical product used to prevent or halt decay in exterior wood; work applied by pressure treatment, soaking or brush.

APPENDICES

APPENDIX B: CLIMATIC DATA

(See Figs. 1.3, 1.4 and 1.5)

Mean Daily Temperature (degrees Celsius)
Source: Environment Canada, Atmospheric Environment Service, *Canadian Normals, Volume 1-S1, 1941-1970,* Downsview, Ontario, 1975

Zone	Location	Data	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Year
1	Resolute, N.W.T	A,c	−32.6	−33.5	−31.3	−23.1	−10.7	− 0.3	4.3	2.7	− 4.9	−14.7	−24.2	−28.8	−16.4
2	Fort Smith, N.W.T	A,b	−26.9	−22.6	−14.6	− 3.2	7.1	13.1	16.1	14.3	7.7	0.5	−11.8	−21.4	− 3.5
2	Kapuskasing, Ont.	CDA,a	−18.3	−16.0	− 9.3	0.7	7.8	14.1	17.0	15.5	10.7	5.3	− 4.1	−14.2	0.8
3	Vancouver, B.C.	A,a	2.4	4.4	5.8	8.9	12.4	15.3	17.4	17.1	14.2	10.1	6.1	3.8	9.8
4	Prince George, B.C.	A,b	−11.8	− 6.2	− 2.1	3.9	9.4	13.0	14.9	13.7	9.8	4.7	− 2.8	− 7.6	3.2
5	Regina, Sask.	A,a	−17.3	−14.3	− 8.3	3.3	10.6	15.3	18.9	17.9	11.6	5.3	− 5.2	−12.9	2.1
6A	Toronto, Ont.	A,a	− 6.3	− 5.8	− 0.9	6.4	12.2	18.2	20.7	20.0	15.7	9.8	3.4	− 3.5	7.5
6B	Halifax, N.S.	A,a	− 3.2	− 3.3	0.1	4.8	9.7	14.4	18.3	18.6	15.6	10.7	5.7	− 0.6	7.6

A — Airport
CDA — Canada Department of Agriculture
a — 30 years between 1941 and 1970, or more
b — 25 to 29 years between 1941 and 1970
c — 20 to 24 years between 1941 and 1970
d — 10 to 29 years between 1941 and 1970

Mean Total Precipitation (Millimetres)
Source: Environment Canada, Atmospheric Environment Service, *Canadian Normals, Volume 2-S1, 1941-1970,* Downsview, Ontario, 1975

Zone	Location	Data	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Year
1	Resolute, N.W.T	A,c	2.8	3.3	3.0	5.8	8.6	12.4	26.4	30.5	17.8	15.2	5.6	4.8	136.2
2	Fort Smith, N.W.T	A,b	17.5	15.5	14.5	17.5	24.6	33.8	52.8	37.8	37.6	28.7	27.7	23.1	331.1
2	Kapuskasing, Ont.	CDA,a	45.0	46.5	49.3	42.9	71.4	77.5	88.9	88.1	84.3	69.6	76.7	53.8	794.0
3	Vancouver, B.C.	A,a	147.3	116.6	93.7	61.0	47.5	45.2	29.7	37.1	61.2	122.2	141.2	165.4	1068.1
4	Prince George, B.C.	A,b	59.2	42.9	31.5	29.5	42.2	58.2	57.9	73.4	55.9	61.0	54.9	54.1	620.7
5	Regina, Sask.	A,a	18.0	17.3	18.3	23.4	40.9	82.6	57.9	49.8	36.3	19.1	18.0	16.3	397.9
6A	Toronto, Ont.	A,a	55.6	49.5	59.9	64.5	72.6	61.2	74.9	73.2	63.2	58.7	61.0	57.7	752.0
6B	Halifax, N.S.	A,a	132.8	120.7	103.1	99.1	106.4	83.8	93.0	94.7	97.3	115.3	144.3	128.3	1318.8

A — Airport
CDA — Canada Department of Agriculture
a — 30 years between 1941 and 1970, or more
b — 25 to 29 years between 1941 and 1970
c — 20 to 24 years between 1941 and 1970
d — 10 to 29 years between 1941 and 1970

Number of Hours With Bright Sunshine

Source: B.J. Yorke and G.R. Kendall, *Daily Bright Sunshine, 1941-1970,* Atmospheric Environment Service, Department of the Environment, Canada, Downsview, Ontario, 1972

Zone	Location	Data	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Year
1	Resolute, N.W.T	A,d	0	17	145	267	274	244	276	159	56	21	0	0	1459
2	Fort Smith, N.W.T	A,d	60	110	175	235	283	302	299	261	125	90	47	30	2017
2	Kapuskasing, Ont.	CDA,a	76	104	143	165	190	215	233	203	122	92	40	52	1635
3	Vancouver, B.C.	A,d	55	93	129	180	253	243	305	255	188	116	70	44	1931
4	Prince George, B.C.	A,a	54	89	139	187	255	256	279	245	158	104	60	39	1865
5	Regina, Sask.	A,a	98	117	156	210	271	253	337	293	194	169	96	83	2277
6A	Toronto, Ont.	A,a	87	110	145	179	221	256	281	257	197	153	82	77	2045
6B	Halifax, N.S.	A,d	93	117	144	162	204	206	230	219	176	154	93	85	1883

A — Airport
CDA — Canada Department of Agriculture
a — 30 years between 1941 and 1970, or more
b — 25 to 29 years between 1941 and 1970
c — 20 to 24 years between 1941 and 1970
d — 10 to 29 years between 1941 and 1970

APPENDIX C: TYPICAL MAINTENANCE SCHEDULE

(Note: Adapt to meet local needs)

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
A. LAWN AREAS							
1 Water					x	A	
2 Mow		x				B	
3 Edge			x			C	
4 Weed Control					x		
5 Pest Control					x		
6 Fertilize				x		D	
7 Trash Pick-up	x					E	
8 Rake					x		
9 Aerate/Verticut				x		F	
10 Rolling				x		G	

A. During season, approximately 1 June to 15 September
B. During season, approximately May to October
C. Every second mowing
D. Once in spring, or once in fall if preferred
E. Combine daily patrol with pick-up patrol
F. Aerate once when moisture is right
G. Do as rarely as possible to facilitate cutting; not more than once a year

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
B. PLANTED GROUNDCOVER AREAS							
1 Water					x	A	
2 Prune				x		B	
3 Edge					x	C	
4 Weed Control					x		
5 Pest Control					x		
6 Fertilize				x		D	
7 Trash Pick-up	x						
8 Cultivate					x	E	
9 Care of Bulbs and/or Perennial Materials					x		

A. In season
B. To retain form and prevent crowding
C. Distinct edge will improve appearance
D. Once in May, again in August if possible
E. To control weeds and provide soft soil mulch

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
C. SHRUB AND TREE AREAS							
1 Water					x	A	
2 Prune and						B	
Removal				x			
3 Edge				x			
4 Weed Control					x		
5 Pest Control					x		
6 Fertilize				x		C	
7 Trash Pick-up		x					
8 Remulch					x		
9 Cultivate			x			D	
10 Supports and Guards					x		
11 Hedges				x		E	
12 Winterize (Burlap Wrap)				x			

A. In periods of dry weather
B. In season to remove seeds, control size and remove undesirable growth
C. To stimulate growth in spring
D. To control weeds and keep attractive
E. Trim to maintain shape

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
D. NON-PAVED SURFACE AREAS							
1 Trash Pick-up	x					A	
2 Wash Off					x		
3 Surface Recondition				x			
4 Rake			x			B	

A. If kept clean at start, winds will help to maintain it that way
B. Or as required

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
E. PATIO OR PAVED USE AREAS							
1 Trash Pick-up	x						
2 Sweep		x					
3 Wash Off			x				
4 Disinfect				x			
5 Reset and Relevel				x			
6 Weed				x			
7 Snow Removal					x		

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
F. PARKING AREA							
1 Trash Pick-up	x						
2 Sweep		x					
3 Wash Off				x			
4 Restripe and Mark				x			
5 Surface Seal				x			
6 Snow Removal					x		

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
G. ROADWAYS							
1 Trash Pick-up	x						
2 Sweep		x			x		
3 Wash Off			x				
4 Restripe and Mark				x			
5 Surface Seal				x			
6 Snow Removal					x	A	
7 Visibility for Exit					x	B	

A. Remove to prevent site encroachment
B. Trim plantings to provide safe viewing of traffic

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
H. WALKS							
1 Trash Pick-up	x					A	
2 Sweep		x					
3 Wash Off			x			B	
4 De-Weed Cracks				x			
5 Snow Removal					x	C	
6 Traffic Visibility					x	D	
7 Corrections					x	E	

A. Combine with daily site patrol
B. Or as required
C. As required to allow use
D. Trim shrubs and trees to preserve sight distance
E. Adjust according to use

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
I. STORAGE AND SERVICE AREAS							
1 Trash Pick-up	x						
2 Weed Removal				x			
3 Surface Conditioning				x			
4 Pest Control					x		
5 Rodent Control					x		

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
J. WALLS AND FENCES							
1 Trash Pick-up	x						
2 Weed Control				x	x		
3 Repairs			x			A	

A. Or as required

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
K. STEEP SLOPES							
1 Erosion Control			x		x	A	
2 Redo Surface Materials				x	x		

A. Check monthly; correct as required

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
L. SURFACE DRAINAGE							
1 Trash Removal					x		
2 Weed Control					x		

Site Areas and Maintenance Activities	Day	Week	Month	Year	As Needed	Notes	Work Completed Dates
M. MISCELLANEOUS							
1 Drainage Clean-Out				x		A	
2 Tennis Courts			x				
3 Pools							
• Water Quality, Leaf Removal		x					
• Winter Covering				x			

A. Check culverts, catch basins and general drainage system in autumn after fall of leaves and before freezing

APPENDIX D: TYPICAL LANDSCAPE MAINTENANCE SPECIFICATION

PART 1 — GENERAL

1.1 Description of Work

.1 Spring (including sweeping, hosing down and cleaning of hard surfaces) and fall cleaning; seasonal conditioning of soil and plant material.

.2 Fertilizer-herbicide applications.

.3 Shrub and tree maintenance.

.4 Grass cutting and weed control.

.5 Resodding.

.6 Top dressing and seeding.

Spec. Note: Amend 1.1 to suit project requirements.

.7 Various landscape maintenance operations specified are to be carried out on a project known as [_____] located in [_____], [_____] from [_____ 19____] to [_____ 19____].

Spec. Note: Complete 1.2.7 with project name and geographical location, (i.e., municipality and province) and time period of this contract.

1.2 Additional Instructions to Tenderers

.1 Tenderers to complete "DETAILS OF PRICE" section on attached Supplement A, "TYPICAL COST SUPPLEMENT FOR LANDSCAPE MAINTENANCE CONTRACTS".

Spec. Note: Amend 1.2.1 to suite contract requirements.

1.3 General Workmanship

.1 Program timing of operations to growth, weather conditions and use of site.

.2 Notify [Owner's Representative], [Project Superintendent] at least 7 days before the various operations noted in 1.1 begin.

.3 Do each operation continuously and complete within reasonable period.

.4 Obtain acceptance in writing from [Owner's Representative], [Project Superintendent], with detailed description of work completed before the submission of progress claims.

Spec. Note: Amend 1.2.2 and 1.2.4 to suit project requirements.

1.4 Delivery and Storage

.1 The Owner will provide storage around buildings to be maintained by Contractor.

.2 Deliver and store fertilizer and other packaged materials in waterproof bags with manufacturer's seals and labels intact and showing [weight], [mass] analysis.

.3 Protect materials from weather while they are in transit.

.4 Store materials on raised supports.

.5 Cover materials stored on site with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of physical properties.

.6 Store materials in accordance with manufacturer's instructions.

.7 Plant materials must be transported and stored on site in accordance with the Guide Specifications for Nursery Stock of the Canadian Nursery Trades Association.

.8 Materials are stored on site at one's own risk.

Spec. Note: Delete 1.3.1 if not applicable and renumber remaining paragraphs.

1.5 Occupancy

.1 Carry out work in such a manner as to cause as little inconvenience as possible to occupants.

1.6 Clean-up

.1 At end of each day and on completion of work in specific areas, remove from the site empty fertilizer bags, surplus materials, tools, equipment and debris. On completion of work, leave site in clean, tidy condition.

.2 Do not burn debris on site.

1.7 Making Good

.1 Repair and make good to satisfaction of [_____] any damage caused to buildings or property during performance of this Contract.

PART 2 — PRODUCTS

2.1 Materials

.1 Topsoil: clean friable agricultural loam containing a minimum of 4 per cent organic matter for clay loams and 2 per cent for sandy loams, to a maximum of 25 per cent by volume, free of subsoil, roots, sod, stones and foreign objects. Acidity range (pH) of 5.5 to 7.5. Topsoil containing crabgrass, couchgrass or other noxious weeds is not acceptable.

.2 Fertilizer: complete commercial fertilizer, [_____] with 50 per cent of elements derived from organic sources of non-burning type with slow nitrogen release.

Spec. Note Local conditions to determine analysis of fertilizer used; insert required analysis.

.3 Water: potable.

.4 Grass seed: should conform to federal and provincial seed laws and have a minimum germination of 75 per cent and a minimum purity of 97 per cent; to consist of 50 per cent Kentucky Blue Grass, 40 per cent Creeping Red Fescue and 10 per cent Rye Grass.

.5 Nursery sod: nursery field turf grass crop, consisting of 50 per cent Kentucky Blue Grass, 45 per cent Creeping Red Fescue, 5 per cent Perennial Rye or Red Top, thickness of sodsoil portion 25 mm maximum. Sod with soil visible when grass is mowed to 40 mm height is not acceptable.

.6 Plant Materials: use only compact sturdy plants with a well-developed root system. Plants may not have been crowded in flats and must be sufficiently large enough by planting-out time.

.7 Weed Killer:

.1 Type 1: 2,4-D amine
.2 Type 2: Fenoprop (silvex)

.8 Pest and disease sprays: 50 per cent malathion will be effective in most instances. Do not use DDT.

.9 Contact or systemic insecticide similar to Cygon 2E.

Spec. Note: Amend 2.1.7, .8 and .9 for equivalent products most favoured locally.

.10 Stakes: T-rail iron stakes 40 × 40 × 5 mm × 2400 mm long primed with 1 brush coat of black zinc rich paint to CGSB 1-GP-181M.

.11 Snow fence: standard model with slats dipped in chemical preservative, spaced and tied together with steel wire, making a continuous fence.

.12 Wound dressing: horticulturally accepted non-toxic non-hardening emulsion.

Spec. Note: Amend 2.1 to suit project requirements.

PART 3 — EXECUTION

Spec. Note: Paragraphs in 3 which are not applicable to specific project requirements should be deleted and the remaining paragraphs renumbered.

3.1 Site Cleaning

.1 First phase of work consisting of spring cleaning to begin in mid-April or when areas are clear of ice and snow and as detailed in 3.2.

.2 All work included in this section to be completed within two weeks of commencement.

.3 Second phase of work consisting of fall cleaning as detailed in 3.3.

3.2 Spring Cleaning

.1 Paved areas: [parking areas], [driveways], [sidewalks], [play areas], [patios] to be thoroughly cleaned and swept clear of sand, silt and other winter debris.

Spec. Note: Amend 3.2.1 to suit project requirements.

.2 Grass areas: grass areas to be cleaned by first picking up stones, branches, paper, glass and other debris. Complete grass area to be raked with flexible spring steel rake to remove dead vegetation material and any other debris. Tractor-drawn mechanical sweepers will not be permitted for the *spring* cleaning operations but will be allowed for the *fall* cleaning operation.

.3 Catch Basins: catch basins on owner's property to be opened and all debris removed. Locations of catch basins to be determined by owner's personnel.

.4 [Shrub beds], [hedges], [foundation planting] to be thoroughly cleaned to remove debris in or near these areas.

Spec. Note: Amend 3.2.4 to suit project requirements. Delete if not applicable and renumber as required.

.5 Window wells shall be cleaned of debris and vegetation. After cleaning, window well covers shall be replaced to satisfaction of owner.

Spec. Note: Delete 3.2.5 if not applicable to project requirements.

3.3 Fall Cleaning

.1 This phase of contract covers same operations specified for spring; i.e., raking, cleaning of catch basins and planting areas.

.2 Sweep up and dispose of leaves within project boundaries.

.3 Shrubs planted in current year shall be wrapped in accordance with good landscape practice.

.4 After cleaning, ensure that window well covers are securely in place.

.5 Fall cleaning to be completed by end of October.

Spec. Note: Delete 3.3 if not applicable to project requirements and renumber remaining paragraphs.

3.4 Fertilizer-Herbicide Application to Grass

.1 All grass areas to be fertilized.

.2 First application each spring to take place when temperature reaches 20°C [approximate date], and 18kg quantity of fertilizer/herbicide to cover a grass area not exceeding 370 m².

Spec. Note: Owner to insert applicable month or week in space provided.

.3 Second spreading of fertilizer is to be applied at [_____], coverage not to exceed 18 kg per 465 m².

Spec Note: Owner to insert appropriate month or week in space provided.

3.5 Method of Spreading Fertilizer-Herbicide

.1 Only mechanical means to be used for fertilizer and herbicide applications.

.2 Power-operated spreaders may be used if approved by owner

.3 Where grass growth indicates uneven coverage or missed areas after either application, contractor is to apply, at no extra cost to owner, supplementary fertilizer to produce a finish acceptable to owner.

3.6 Shrub and Tree Maintenance

.1 Carry out initial treatment on shrubs and trees and monthly thereafter for five consecutive months.

3.7 Shrub and Tree Fertilization

.1 Shrubs to have 6-9-6 or 4-12-8 fertilizer, nitrogen component to contain at least 50 per cent urea formaldehyde.

.2 Fertilizer to be worked into specific cultivated areas at following rates:

.1 0.5 kg for individual shrubs.
.2 A maximum of 25 kg per 30 m for hedges.
.3 A maximum of 25 kg per 90 m² for mass planting.

.3 Initial application of this fertilizer to be completed by 15 May.

.4 Trees within paved areas to have fertilizer applied to surrounding cultivated area at rate of 1.5 kg per 25 mm of caliper, measured 300 mm above ground level.

Spec. Note: Delete paragraphs of 3.7 not applicable and renumber remaining ones.

3.8 Soil Fertilization

.1 Shrubs, hedges and shrub beds to have a suitable surrounding area thoroughly cultivated by end of May.

.2 Complete soil area about trees planted in paved areas to be cultivated as in 3.8.1.

.3 Shallow cultivation to be carried out on areas noted in 3.8.1 and 3.8.2 at monthly intervals for the five consecutive months noted in 3.6.1

3.9 Pruning and Trimming

.1 Shrubs:

.1 On the first and subsequent monthly visits, dead, broken or diseased branches to be removed from shrubs.

.2 Prune flowering shrubs in accordance with their flowering habit to produce optimum bloom.

.3 Shrubs flowering on current season's growth to be pruned in early spring before leaves appear. Shrubs flowering from previous season's growth to be pruned immediately after flowering.

.4 Maintain shrubs used as foundation planting, boundary screens or in shrub beds in free form.

.5 Control height and shape by cutting back selected branches slightly above a joint and remove excessive lateral branching. Maximum height permitted not to exceed two (2) m. Prune monthly in accordance with good horticultural practice.

.6 Uniform shearing is not permitted.

.7 Obvious volunteer shrub or tree growth present in foundation planting, shrub beds or near fencing to be completely removed to ground level.

.2 Trees:

.1 Remove dead, diseased or broken branches to a height of 2.5 m above ground level.

.2 Remove living branches that are forked double leaders or are narrowly crotched so that they are interfering with the development of a well- shaped tree.

.3 Cuts made in pruning operations to be in accordance with good arboricultural practice, with no stubs to be evident after pruning.

.4 Cuts in excess of 12 mm diameter to be treated with protective tree-wound dressing specified in 2.1.12.

3.10 Insect and Disease Control

.1 Apply a contact or systemic insecticide on [flowering crab apples] [birch trees].

Spec. Note: Delete 3.10.1 if not applicable and renumber remaining paragraphs.

.2 Report immediately to owner any evidence of other insect disease or fungal damage.

3.11 Wounds

.1 Wounds to be covered with a protective tree dressing.

.2 In case of new wounds, remove loose bark.

.3 Bark cuts to be in form of ellipse with its long axis along trunk.

.4 Remove previously applied dressing.

.5 Do wound work initially in [_____] and monthly for new wounds.

Spec. Note: Owner to insert name of month.

3.12 Dead Tree Removal

.1 Be responsible for dead tree removal.

.2 Roots of trees up to 75 mm caliper to be removed and earth levelled.

.3 Above 75 mm caliper tree trunks to be cut flush to or below ground level.

.4 Tree caliper to be determined 300 mm above ground level.

3.13 Grass Cutting

.1 Grass to be cut three times per month during entire growing season or as otherwise required by [_____].

.2 Commence lawn mowing within [ ] hours upon request of designated representative [_____]. Operation must be continuous and completed within reasonable period.

Spec. Note: Complete 3.13.2 in accordance with local practice.

.3 Lawn cutting includes picking up and disposal of paper and refuse accumulated on landscaped areas.

.4 Cut grass to height of [40 mm]. Use equipment in good working order and with sharp cutting blades. Mow grass on average once every ten days. Do not remove grass clippings from lawn unless volume is such as to be harmful to lawn. Hand trim or use edger for grass adjacent to buildings, pavement, trees and fences. Trim grass edges around planting beds neatly in lines as in original layout.

Spec. Note: Use this paragraph for highly maintained areas such as building entrances, courtyards and small urban sites.

.5 Cut grass to height of [40 mm]. Use equipment in good working condition and with sharp cutting blades. Mow grass on average once every twenty days. Mow edges as close as possible with power equipment.

Spec. Note: Use 3.13.5 for medium-maintained areas,such as large park-like areas. If not applicable,delete and renumber remaining paragraphs.

.6 Use power equipment, satisfactory to designated representative [_____], to cut grass no lower than [50 mm]. Mow grass on average of three times during growing season. Allow for easy handling of grass cuttings. Remove cuttings from site if they will smother grass underneath. Mow edges as close as possible with power equipment.

Spec. Note: Use paragraph 3.13.6 for low maintained areas such as highway boulevards. For minor projects, use paragraph 3.13.4. For major projects use paragraph 3.13.4. For major projects use paragraphs 3.13.4, 3.13.5, 3.13.6 as required by project characteristics. Renumber if any paragraphs are deleted.

.7 For weed and grass control, spray paved, gravel or stone-surfaced areas with foliar sprays of weed killers specified in 3.1.7, according to manufacturer's instructions.

.8 For areas other than surfaced and mown grass areas which support vegetation, use a selective broad-leaved weed killer in early June and early September.

Spec. Note: Depending on local practice, the week or month of application may change.

3.14 Repair and Renovating

.1 Regrading;

.1 Remove sod and topsoil from areas requiring regrading. Regrade to new elevations with subgrade [0.15 m] below final grade.

.2 Remove excess material from site or supply and spread fill to bring subgrade to required elevations.

.3 After regrading subgrade, supply and spread topsoil to depth of [0.15 m].

.2 Reseeding:

.1 Loosen topsoil of areas to be reseeded by roto-tilling or discing. Remove stones, debris, grass or weeds. Prepare smooth and loose seedbed.

.2 Apply 10-6-4 fertilizer at rate of [12 kg/ 10 m²]. Rake into top layer of soil.

.3 Use seed mixture similar to one growing on site; it should be suitable for regional growing conditions.

Spec. Note: See 2.1.4 for grass seed mixture.

.4 Seed at rate specified for seed mixture but not less than 12 kg/100 m².

.5 Incorporate seed into soil within one hour after seeding. Mix with light chain harrow or wire rakes. Roll areas immediately afterwards with light turf roller.

.6 Water entire area with fine spray. Avoid washing out seed. Water to ensure penetration of [50 mm]. Continue watering at intervals to maintain sufficient growth. After germination, keep grass cut to height of [40 mm].

.3 Resodding:

.1 Remove existing and dead sod, weeds and debris from area to be resodded. Loosen top layer by discing or roto-tilling. Prepare smooth, loose surface for laying sod.

.2 Apply 10-6-4 fertilizer at rate of [12 kg/ 200 m²]. Rake into top layer of soil.

.3 Use sod with grass mixture similar to one growing on site. If correct mixture is not known, use only sod which, in appearance, equals existing lawn free of weeds or other objectionable plant growth.

Spec. Note: If area to be resodded is directly adjacent to area(s) with heavy infestation of weeds, such areas also should be regraded and resodded.

.4 Lay sod with sections closely butted, without overlapping of gaps, smooth and even with adjoining areas. Roll lightly and tamp. Water to obtain moisture penetration of 75 to 100 mm. Continue watering at intervals to maintain sufficient growth. Keep grass cut to height of 40 mm.

.4 Top dressing and reseeding:

.1 Mow areas to receive top-dressing to height of 40 mm.

.2 Rake thoroughly, removing loose and dead grass, stones and debris.

.3 Use dry topsoil and spread to thickness of 6 to 12 mm, filling in low areas and bare spots.

.4 Overseed area with seed mixture similar to one growing on site and suitable for region. Seed at rate of 1.75 kg/100 m².

Spec. Note: See 2.1.4 for grass seed mixture.

.5 Mix topsoil and seed by heavy raking. Water to ensure close contact between sod, seed and top-dressing. Roll lightly after soil has dried sufficiently to avoid adherence to roller.

.5 Apply water to ensure deep penetration and at sufficient intervals to maintain vigorous growth. Keep grass cut to height of 40 mm.

.6 Paving:

.1 Reset paving slabs of patios and walkways where settlement occurred. Provide sand if necessary.

.2 Repair damage to walkways and steps caused by frost. Do patchwork to match existing material, colour, texture and elevation.

Spec. Note: Delete 3.14.6 if not applicable.

3.15 Winter Preparation

.1 Snow fencing and T-rails will be supplied by [_____]. Install snow fencing at locations directed by owner's representative.

.2 Snow fencing to be installed on 2400 mm long T-rails, driven into soil not less than 1200 mm.

.3 Brace corner posts securely in two directions to owner's representative's [_____] approval.

.4 Fencing to be securely wired to T-rails at top of fencing and ground level.

.5 T-rails placed as directed by owner to indicate curbs, edge of pavement, catch basins, and fire hydrants which have to be located after snowstorm.

Spec. Note: Delete paragraphs not applicable and renumber remaining ones.

3.16 Payment

.1 Payment for various operations under landscape maintenance contracts are to be based on following:

.1 Complete "Details of Price" section on the enclosed Supplement A, "TYPICAL COST SUPPLEMENT FOR LANDSCAPE MAINTENANCE CONTRACTS".

.2 Spring and fall cleaning to be on a fixed price basis.

.3 Fertilizer-herbicide application to be a unit price per [tonne][kilogram] for both applications.

.4 Shrub and tree maintenance to be a fixed price for complete treatment.

.5 Tree removal at unit price; separate for up to 75 mm diameter, 75 to 150 mm, 150 to 300 mm, and larger.

.6 Grass cutting at unit price per cut, price for eighteen cuts.

.7 Resodding at unit price per square metre laid.

.8 Top soil at unit price per cubic metre in place.

.9 Snow fencing at unit price per metre in place.

Spec. Note: Amend 3.16 to suit project requirements.

SUPPLEMENT "A"

TYPICAL COST SUPPLEMENT FOR LANDSCAPE MAINTENANCE CONTRACTS

General Description of Work

1. Spring and Fall Cleaning
2. Fertilizer — Herbicide Application
3. Shrub and Tree Maintenance
4. Tree Removal
5. Grass Cutting and Weed Control
6. Resodding
7. Top Dressing and Seeding
8. Snow Fencing

Details of Price

No.	Item	Unit of Measurement	Unit Price	Quantity	Total Price
1.	Spring and Fall Cleaning Fixed Price	_____	$_____	_____	$_____
2.	Fertilizer — Herbicide Application	kg	_____	_____	_____
3.	Shrub and Tree Maintenance Fixed Price (for complete seasonal treatment)	_____	_____	_____	_____
4.	Tree Removal				
	a) Up to 75 mm	ea	_____	_____	_____
	b) 75 to 150 mm	ea	_____	_____	_____
	c) 150 to 300 mm	ea	_____	_____	_____
	d) larger than 300 mm	ea	_____	_____	_____
5.	Grass Cutting	ea	_____	18 cuts	_____
6.	Resodding	m^2	_____	_____	_____
7.	Trop Dressing and Seeding	m^2	_____	_____	_____
8.	Snow Fencing	m	_____	_____	_____
			Total		$_____

Spec. Note: Amend form of contract, if existing, to suit project requirements.

APPENDICES

APPENDIX E: REFERENCES

References	Applicable to Chapter(s)
Canada Mortgage and Housing Corporation, *The Conservation of Energy in Housing*, NHA 5149. 1981.	2, 3, 5
Canada Mortgage and Housing Corporation, *Outdoor Living Areas: Advisory Document*. NHA 5329. 1980.	2,4
Canada Mortgage and Housing Corporation, *Parking Areas: Advisory Document*, NHA 5239. 1980.	2
Canada Mortgage and Housing Corporation, *Play Opportunities for School-Age Children, 6-14 Years of Age: Advisory Document*, NHA 5318. 1980.	2
Canada Mortgage and Housing Corporation, *Residential Site Development: Advisory Document*, NHA 5364. 1981.	1, 2, 3
Canada Mortgage and Housing Corporation, *Site Landscape for New Housing* (information pamphlets), NHA 5176-1 to 14. 1980.	1, 3
Canada Mortgage and Housing Corporation, *Housing Disabled Persons*, NHA 5467. 1982.	2
Canada Mortgage and Housing Corporation, *Play Spaces for Preschoolers*, NHA 5138. 1978.	2
Canada Mortgage and Housing Corporation, *Roof Decks: Design Guidelines*, NHA 5220. 1979.	2, 4, 5, 6
Canada Mortgage and Housing Corporation, *Site Planning Criteria, Metric Edition*, NHA 5214. 1978.	2
Carpenter, Jot D., *Handbook of Landscape Architectural Construction*, McLean, Virginia: The Landscape Architecture Foundation, 1976.	3, 4
Carpenter, Philip L., T.D. Walker, F.O. Lanphear, *Plants in the Landscape*, San Francisco: W.H. Freeman and Company, 1975.	5, 6
City of Toronto Planning Board, *Guidelines for the Design of Outdoor Spaces for the Physically Handicapped*, (pamphlet).	1, 2
Conover, A.S., *Grounds Maintenance Handbook*, New York: McGraw-Hill Book Company, 1977.	5, 6
Department of Agriculture, Canada, *Lawns*, Publication 1163. No date.	5, 6
Department of Agriculture, Canada, *Ornamental Shrubs for Canada*, Ottawa, Canada, 1974.	5, 6
Department of Forestry, Canada, *Native Trees of Canada*, Ottawa, Canada, 1966.	5
Department of Public Works, Canada, *Landscape and Site Development*, Ottawa, Canada, 1972.	1, 2, 3 4, 5, 6
Department of Transport, Meteorological Branch, Air Services, *The Climate of Canada*, Toronto, Canada, 1960.	1
Engstrom, R.E. and M. Putman, *Planning and Design of Townhouses and Condominiums*, Washington, D.C.: The Urban Land Institute, 1979.	2, 3

References	Applicable to Chapter(s)
Hackett, Brian, *Planning Design*, New York: McGraw-Hill, 1979.	5
Hannebaum, L.G., *Landscape Operations, Management Methods and Materials*, Reston, Virginia: Reston Publishing Company, Inc., 1980.	6
Knowles, R.H., *Woody Ornamentals for the Prairie Provinces*, Edmonton, Alberta: University of Alberta, 1975.	5, 6
Landscape/Paysage Canada, Canadian Nursery Trades Association, *Guide Specification for Nursery Stock*, Ottawa, 1978.	5, 6
Laurie, Michael, *An Introduction to Landscape Architecture*, New York: American Elsevier Publishing Company, Inc., 1975.	1, 2, 3 4, 5, 6
Lynch, Kevin, *Site Planning*, Second Edition, Cambridge, Mass.: The MIT Press, 1971.	1, 2, 3, 5
Michigan Department of Natural Resources, Division of Land Resources Programs, *Soil Erosion and Sedimentation Control*, Reston, Virginia: Environmental Design Press, 1981.	3, 5
Munson, Albe E., *Construction Design for Landscape Architects,* New York: McGraw-Hill, 1974.	3, 4
National Research Council of Canada, *Building Standards for the Handicapped 1980*, 17669.	1, 2, 3
Newton, Norman, T., *Design on the Land*, Cambridge, Mass.: The Belknap Press of Harvard University Press, 1971.	1
O'Mara, W. Paul, *Residential Development Handbook*, Washington, D.C.: The Urban Land Institute, 1978.	2, 3, 5
Ontario Agricultural College, Department of Land Resource Science, *Ontario Soils*, Ministry of Agriculture and Food, Publication 492; AGDED 500.	5
Robinette, Gary O., *Plants/People and Environmental Quality*, Washington, D.C.: U.S. Department of the Interior, 1972.	5
Simonds, John Ormsbee, *Landscape Architecture, The Shaping of Man's Natural Environment*, New York: McGraw-Hill, 1961.	1, 2
Untermann, Richard K. *Grade Easy*, McLean, Virginia: American Society of Landscape Architects, 1973.	3
Untermann, Richard, Robert Small, *Site Planning for Cluster Housing*, New York: Van Nostrand Reinhold, 1977.	2
U.S. Department of Housing and Urban Development, *Barrier Free Site Design*, Washington, D.C., 1975.	2, 3
Weddle, A.E., *Techniques of Landscape Architecture*, London: Heinemann, 1967.	2, 3, 4, 6

INDEX

access, 13;
  barrier free, 9, 25, 26;
  pedestrian, 7, 42, 68;
  roads, 20 ,22;
  vehicular, 7, 17, 22, 25, 68, 72
administrative restrictions in project design, *12*
aesthetic aspects of landscape design, 3, 10, 11, 13, 21, 33, 84, 86, 99
Agriculture Canada, 87, 92, 115
amenity, 3, 13, 21;
  area, 6, 20, 25, 26
analysis:
  market, 3, 7;
  site, 12, *12*;
  soil, 44, 91
architect, 3, 18, 103, 105
architecture, 7, 87
asphalt, 28, 46, 56, *57*;
  maintenance of, 118
automobile plug-in, 7, 73

backyard, 20
balcony, 20, *111*
barriers, 22, 26, 54
bench, 7, 29, 70, *70*, 71, 120
berm, 17, 24, 33, 44, 45, *45*, 102, 123
block heater. *See* automobile plug-in
bollard, 22, 29, 72-73, *72*, *73*, 123
brick:
  bollard, 72;
  paver, 60-61;
  wall, 64, 65
bubble diagram, 17, *17*
budget, 4, 17, 110
building:
  code, 3, 42;
  design, 8, *8*, 22;
  orientation, 8, 23, 24
by-law, 3, 17, 22, 28, 38, 42, 44, 47

cable television, 7
Canadian Nursery Trades Association, 92, 104
carport, 22, *22*
catch basin, 18, 35, 44, 46, 48, *48*
children, 7, 20, 74;
  play facilities for, 20, 26, 28, 56
circulation routes. *See* pedestrian circulation, vehicle circulation
climate, 4-6, 13, 44, 102;
  influence of, on design, 4, 8, 28, 39, 74;
  control, 64
  See also precipitation, temperature, wind, sun
climatic regions, *4*
communal space, 6, 17, 20-21, 26, 29, 67, 69, 84, 123
community infrastructure, 4, 124
concrete, 39, 46, 57, 72, 74;
  expansion joints, 55, 58, *58*, 118;
  finishes, 44, 58, 123;
  footings, 29, 39, 65, *65*;
  maintenance of, 118;
  pavers, 58-60, *58*, *59*, *60*, 119;
  planter, 71;
  precast, 40;
  walls, 38, 39, 40, 64, *64*, 65, *65*
coniferous trees, 84, 123
construction, 3, 99, 103-104;
  supervision, 105
contours, 35, *35*, *36*, 123
contract, 136;
  documents, 104, 105
contractor, 6, 103, 105

costs, 4, 18, 47, 56;
  capital, 7, 10, 110;
  effectiveness, 3, 56, 81
  maintenance, 7, 18, 110
courtyard, 20
culvert, 44, 47, *47*, 123
curb, 25, *25*, 26, 28, 35, 44, 46, 50, *50*, 56, 74, 123

deciduous plants, 82;
deciduous trees, 84
Department of the Environment. *See* Environment Canada
design, 3, 99;
  components, 9, 11;
  criteria, 20;
  goals, 7;
  process, 12, *12*
designer, 6, 9, 35, 37, 44, 71, 86, 106
disabled, 7, 9, 69, 70;
  barrier free design for, *9*, 25, *25*, 26, *43*
ditch, 35, 44, 46, 47, *47*, 102, *102*, 123
drain, 44, 49, *49*;
  inlet, 35, 44, 46, 48, *48*
drainage, 31, *33*, 34, 56, 106;
  soil, 89;
  structures, 35;
  surface, 11, 22, 33, 35, 44, 89, 125;
  systems, 7, 46
driveway, 24, 34
drystone, 41, *41*, 123

earth berm. *See* berm
easement, 35
economic factors in project design, 6
electrical outlets, 7, 72
electricity, 7, 18
emergency vehicle:
  access, 7, 22, 72
enclosures, 64
energy conservation, 8, *8*, 83
engineer, 3, 18, 39, 44
environment, 13
Environment Canada, Atmospheric Environment Service, 4, 5, 126, 127
erosion control, 47, 60, 81, 85-86, *101*, 123;
  during construction, 101;
  mechanical, 102, *103*;
  vegetative, 85, *85*, 86, 102, *102*

fence, 3, 11, 24, 26, 28, 64, 66-68, *66*, *67*, *68*, 81, 83, 120
fertilization, 115
fire lane. *See* emergency vehicle access
flagstone, 60, 119
flume. *See* swale
footpath. *See* walkway
fountain, 74, 82
frost, 38, 39, 65, 67, 91
furniture. *See* site furniture
functional aspects of overall landscape design, 11, 33

gabion, 101, 102, *102*, 124
garage, 22, 26
garbage:
  collection, 7, 22, 24, 27, *27*;
  storage, 7, 20, 27, *27*, 68, 81, 85
gas, 7
gate, 67
glare:
  control of, 81, 82, *82*
gradient, 17, 26, 34, *34*, 38, 42, 43, 46, 47, 60, 86, 101, 102;
  determination of, 36, *36*

Italics refer to illustrations on that page number.

INDEX

grading, 3, 7, 8, 10, 11, *11*, 17, 31, *33*, 41, 48, 91, 101, 105, 106, 124;
  aesthetic aspects, 33;
  functional aspects, 33, 50;
  plan, 35, 37, *37*, 44, 48, 53, 104, 124
grass, 60, 86, *111*, 124
gravel, 61;
  maintenance of, 119
groundcover, 11, 81, 85, 86, 87, 124
Guide Specification for Nursery Stock, 92, 104

hard landscape materials, *11*, 51;
  See also fence, lighting, paving, screen, signage, site furniture, wall, water features
health requirements, 3, 44
herbicide, 115
housing project:
  density, 3, 6, 26;
  design and development, 3, 13;
  orientation, 23, 24
humidity, 4
hydrology, *12*, 13, 44

insecticide, 115
insulation, 71
investment:
  return on, 4, *7*, 10
irrigation, 6, 7, 44, 89, *89*, 104, 124

lake, 44
land:
  form, 13, 68
  use, 17
landscape, 3, 4;
  construction, 4, 103-104;
  design, 3;
  specifications, 104;
  maintenance, 109, 115
lawn, 7, 11, 20, 26, 53;
  damaged, 26, 117;
  location, 7;
  maintenance of, 116
layout. *See* site layout
legal restrictions in project design, 3, 7, *12*, 13, 21
light control, 81, *82*;
  for plants, 90
lighting, 7, 11, 26, 29, 44, 69, 75, 76, 104, 120;
  fixtures, 75, *75*

maintenance, 3, 7, 9, 11, 91;
  budget, 109, 110, 114, *114*;
  costs, 7, 18, 56, 113;
  in site design, 7, 53, *112*;
  of communal space, 7;
  of private space, 7, 20;
  procedures, 56, 69, *113*, 115, 118;
  program, 29, 104, 109;
  strip, 7, 53, *53*;
  schedule, 113-114, 128-129;
  specifications, 130-135
manhole, 18, *18*, 35, 124
market analysis, 3, 7
material:
  availability of, 6;
  installation of, 106;
  properties of, 56;
  selection of, 53, 101
metal fence, 66
microclimate, *12*, 87, 124
mound, 45, 124
mulch, 85, 89, 115, 124

noise, 26, 33, 45, 56, 64, 68
nutrients, 90

off-site factors in project design, *12*
outdoor living area. *See* private space

park, 4
parking, 7, 17, 20, 22, *22*, 23-24, *23*, *24*, 25, 29;
  drainage of, 7, 22, *46*;
  lot, 7, 27, 34, 56, 82, 84
paved area, 7, 11;
  maintenance of, 118, 119
pavers, 26, *55*, 59-61, *111*, *119*
paving:
  durability of, 56;
  materials, 11, 54, 56-63;
  See also asphalt, concrete, flagstone, brick, gravel, stonedust, shale, wood decking
pedestrian:
  access, 7, 42, 68;
  circulation, 7, 17, 25-26, 46, 54, *55*, 69, 81, 84
  routes, 20, 50, 60, 72;
  safety, 24
pesticide, 115
planning requirements, 34
plant hardiness zones, 87, *88*, 92
planted area, 7, 26, 28, 53, 68, 101;
  maintenance of, 115
planter, 71, *71*, 72, 120
planting:
  methods, 87, *107*, *108*, *109*;
  plan, 104, 106
plants:
  functions, 81-86, *81-86*;
  maintenance, 91, 115, 117;
  material, 11, *11*, 79;
  protection of, 91;
  selected lists of, 93-97;
  selection of, 91, 92;
  texture, 87
play:
  area, 7, 26, 28, 29, 33, 56, 124;
  structures, 29, 74, *74*, 124
pollution, 13, 91
pool, 74, 82
population density. *See* social factors in project design
precipitation, 4, 5, *5*, 35, 89, 126
preschool children. *See* children
private space, 6, 17, 20, 24, 26, 45, 62, 67, 81, 84, 125
project:
  completion, 109
  inspection of, 109
property:
  identification of limits, 35, 53, 54, 84;
  management, 3, 109
public space, 17, 21

rails:
  guard, 38;
  hand, 43
railroad tie, 39, 71, 125
ramp, 25, 26, 38, 42, *42*, 43, *43*, 44, 125
recreation, 3, 13, 17, 26;
  area, 7, 13, 17, 20, 25, 33, 34;
  active, 20, 26, 44;
  passive, 20, 26, 44, 69
regional influences on design, 6
road, 4, 7, 33, 35
roof, 7;
  deck, 20, 26, 62, 71, 74, 125
run-off, 101

safety, 3, 25, 26, 44, 54, 56, 73, 84
school, 4
screen, 17, 24, 64, 68;
  plant, 81, *83*, 84
seating, 26
  See also bench

security, 26, 29, 64
sedimentation, 101
services, 4, 7
  See also automobile plug-in, electrical outlets, irrigation, lighting, water
sewer, 11, 35;
  sanitary, 7;
  storm, 7, 35, 38, 44, 47, 48
shade control, 81
shale, 61;
  maintenance of, 119
shell landscape, 10, 125
shrubs, 11, 81, 84, 86;
  location, 7, 45;
  maintenance of, 91, 115, 116;
  selected list of, *95-97*
sidewalk. *See* walkway
signage, 69, 75, 76, *76*, *77*
site:
  analysis, 12-13, *13*, 35, 89, 104;
  data, 12-13;
  design, 3, 6, 7, 9, 11, 12, 42, 87;
  development, 3, 7, 10, 12, 53;
  features, 4, 13, 17, 35;
  functional aspects of, 7, 11, 84, 87;
  furniture, 7, 11, 29, 69, 120;
  See also bench, bollard, planter, play structure, water features, waste receptacle
  inspection, 105, 114;
  layout, 3, 7, 10, 11, *14*, 15, 17, *18*, 19, *19*, *29*, 48, 53, 56, 84, 101, 104, 106;
  plans, 13, 103, 104, 125;
  specifications, 104;
  survey, 35
slope. *See* gradient
snow, 13
  bylaws, 28;
  control, 81, 83;
  deposition, 8, 83;
  removal, 6, 7, 22, 24, 28, 61, 62, 69, 119;
  storage, 7, 28, *28*
social factors in project design, 3, 6, 22
soil, *12*, 13, 37, 71, 89, 101, 102, 105, 106;
  analysis, 44, 91;
  conditions, 13, 39, 40, 65, 74;
  cut, 37, *37*, 45, 123;
  drainage, 35, 89;
  engineering, 13, 65;
  fill, 37, *37*, 45, 124;
  nutrients, 90;
  properties of, 56, 89, 90, 115, 123;
  texture, 90
solar access, 8
space:
  definition of usable, 81
speed bump, 28
spot elevation, 35, *35*
steel, 72
steps, 9, 26, 35, 38, 42, 43, 44;
  handrails for, 43;
  lighting for, 75
stone, 46, 101, 102;
  bollards, 72;
  crushed, 38, 39, 41, *67*, 118, 123,
  walls, 38, 40, 64
stonedust, 61, 125;
  maintenance of, 119
storage area, 7, 20
storm sewer. *See* sewer, storm
strip drain, 49
sump area, 48, 49
sun, 13, 82, 90;
  hours of, 4, 5, *5*, 127
surface, 34;
  water, 33, 35, 44, 46, 89, 101
swale, 10, 17, 34, 35, 44, 46, 47

technical specifications, 104
telephone, 7, 18
temperature, 4, *4*, 126
tender documents, 104
terrace, 20, 38, *38*, 62, *62*, 86, 102
timber. *See* wood
tile:
  drain, 49;
  paving, 60
topography, 8, *12*, 22, 31, 35, 125
topsoil. *See* soil
traffic:
  pedestrian, 25, 46, 60;
  vehicular, 17, 22, 25
trees, 11, 13, 81
  grading around, 41;
  location, 45;
  maintenance of, 91, 115, 116;
  protection of, 41, *41*, *42*, *91*;
  selected list, *93*, *94*;
  well, 41
turning radius for vehicles, 22, *27*

units:
  orientation of, 23, *23*, 24, *24*
utilities, 4, 7, 9, 13, 18, 33, 35, 125
  See also electricity, gas, irrigation, lighting, water

valve, 18
vandalism, 29, 70, *70*, 75, 91, 109, 117
vegetation, *12*, 13, 24, 33, 101, 102, *111*;
  protection of, 105, *105*
vegetative shelterbelt, *83*
vehicle, 50;
  access, 7, 17, 22, 25, 68, 72;
  circulation, 17;
  emergency, 22
view, 13, 25, 82
vine, 81, 87
visual control, 17, 45, 64, 68, 81, 85
  See also screen

walkway, 4, 10, 20, 25, 26, 27, 28, 33, 34, 35, *54*, *55*, 56;
  lighting of, 75
wall, 11, 24, 28, 38, 64, 68, 81;
  brick, 65;
  concrete, 38, *39*, *40*, 65;
  drystone, 41, *41*;
  footings, 38, 65, *65*;
  foundations, 38;
  retaining, 9, 17, 35, 38, *38*, 39, 42, 64, 101, 102
  stone, 38, 40;
  wood, 38, 39, *39*, 66
waste receptacle, 7, 70, 71
water, 7, 18, 33, 35, 46, 71;
  features, 74, 82;
  retention pond, 44, *44*, 101, 102, 125;
  table, 35, 125
weather protection, 6
wind, 4, 6, 8, 13, 91;
  control, 6, 33, 45, 68, 81, 83;
  prevailing, 6, 83
wood, 72, 74;
  decking, 62, *62*, 119, 123;
  fence, 38, 39, 66;
  maintenance of, 119;
  planter, 71
working drawings, 104

zoning, 3